Engineering Record

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American International Corporation

NOTE was made in this journal recently of the organization of a $50,000,000 international promotional and trading corporation, known as the American International Corporation. The organization of the new company has been rightly hailed as the greatest single step taken by American business to cope with the problems of international trade. In saying this, the progress made by the United States Steel Products Company, the Standard Oil Company, and other large American businesses in foreign markets is not lost sight of. The new company, though, in its function as a financing and development agency, has a wider scope. From the caliber of its management one would expect every means essential to the widest success to be employed. Consequently the purchase of seven ships from the Pacific Mail Steamship Company this week need not cause surprise. The promptness of the company's start augurs well, however, for its progress.

Railways and Preparedness

COMMENTING last week on Mr. Dixon's views on the relation of railways to military preparedness, which were published in the Engineering Record of Dec. 11, page 737, the New York *Times* expressed views which need no comment in this journal. They are very much to the point at a time when the President has urged a new study of the railway problem. The *Times* says: "The war on the railways by the enemy within the gates is a more serious matter than the need of the railways against imaginary hostilities in an indefinite future. The indemnities which Germany is levying upon the lands which it has conquered are surpassed by the tribute on our railways by those who are extorting rates below cost and wages above merit." The *Times* does not disagree in the least with Mr. Dixon. It merely takes advantage of the occasion to express aptly the need of the railways for fairer treatment.

Let Contracts Early

MUCH favorable comment has been received by the Engineering Record upon its editorials urging engineers to let their contracts for next year's work as early as possible. One correspondent, after expressing the view that the editorials were not strong enough in urging the engineer to action, remarked that a similar campaign should be waged each year. He pointed out that the records of the cement companies show that the maximum shipments are in September and October, at a time when the construction peak should be past and cement consumption be on the decline. While all work is not made more expensive by cold weather, concreting certainly costs more when there is danger of frost. Our correspondent's advice is well worth while. Taken generally, contracts are not let early enough, and if there be need in normal years for urging the engineer to be forehanded, there certainly ought to be much greater emphasis at the present time upon early contract letting. Shortage and high prices of materials and of contractors' equipment are to be expected. Under such circumstances the contracts let earliest will have the greatest advantage.

Economy Records

OCCASIONALLY records for economy have been made by blindly neglecting necessary public-works construction. The public is dazzled by the contrasting figures, invariably well advertised, but remains ignorant of the amount of necessary work that has been delayed. Generally the deception succeeds in its purpose—that of enhancing the reputation of the fact-suppressing official. If the public were fully informed as to the means by which the record was made, the plan would not be quite so popular The taxpayer would not be elated at a large saving if he were shown that the neglect of the distribution system in his waterworks department had kept his insurance rates abnormally high or caused them to be raised. Nor would any saving to the city treasury mollify his feelings if the postponement of filtration work was menacing his family constantly with typhoid. Economy in office is highly commendable, but should not be attained at the expense of necessary construction. Economy under such circumstances is not an achievement. The public's health, comfort and safety are of more value than its dollars.

Prejudicing the Young Engineer

A CORRESPONDENT who is deeply interested in the movement now afoot to give the engineer his proper place in public life points out what he considers the failure of engineering instructors to impart to their students an appreciation of their reciprocal obligations toward the public. If, he reasons, the public is to have a proper respect for the engineer, the engineer in turn must be in sympathy with the public and tolerant of its point of view. Instructors in engineering are wont, he says, to pick to pieces in a sarcastic and contemptuous way the proposals regarding public projects made by representatives of the people. Such a procedure amuses the class, but puts the students in the same frame of mind as the instructor—entirely out of sympathy with the people he serves. References to the mayor of a town as "a gentleman of average intelligence" or to a town council as "a body of farmers," when said with a sarcastic inflection, do not conduce to the development of the sympathetic relations which should exist between the engineer and the public. The Engineering Record agrees heartily with its correspondent. Certainly a superior attitude of mind on the part of the engineer toward those whom he serves will sooner or later show itself and result in refusal to accord the professional man the position that he believes should be his. In time, no doubt, this superior attitude would be dispelled by frequent contact with clients, but meanwhile much irretrievable damage may have been done.

New York Pier Construction

MAXIMUM economy in combined first cost and maintenance is claimed by C. W. Staniford, chief engineer of the New York Department of Docks and Ferries, for the pier construction now being used in South Brooklyn. Extended study has convinced him that the best solution of the pier problem, as presented in the Port of New York, is a combination of a concrete deck with a pile substructure. The deck is absolutely permanent, while the substructure is permanent below about high-water line, and easily and cheaply repaired above that level. Except for the asphalt covering of the concrete deck, the new type costs no more than the timber-decked piers formerly in use, while the cost of deck repairs is almost entirely eliminated. A description of a pier of this type will be found in an article elsewhere in this issue. One noteworthy advantage of the timber and pile substructure over all-concrete construction, aside from the matter of cost already mentioned, is its greater flexibility and elasticity under the inevitable shock from vessels. Either the vessel or the pier, with the concrete design, is in danger of serious damage. The timber structure, on the other hand, acts as a shock absorber, and dissipates the effect of impact for both vessel and pier. Another point deserving note in connection with the structure described is the cargo-hoist design. Much attention has been given in this country to various types of apparatus for handling cargo economically. These have been considered by the Department of Docks and Ferries, and the decision reached to adhere to the device customary in American harbor practice. It is more simple than the derricks and cranes of European ports and, in the judgment of the department, is economical and effective.

Constructive Commission Work

THERE was much speculation when the Federal Trade Commission was authorized by Congress, and also at the time of its appointment, regarding the attitude it would take toward the work entrusted to it. There was a chance for mischief, measurable only by the tremendous size of the business interests of the country. It is gratifying to record, therefore, the constructive attitude which the commission has taken, an attitude apparent in the investigations it has made, and still more so in an address delivered early this month by the vice-chairman, Edward N. Hurley, before the Association of National Advertisers in New York City. The theme of his address was the way in which the commission may be helpful to American business. After commending the spirit in which the commercial interests of the country have placed facts at the disposal of the commission, he pointed out that great good may come from the collection and publication of essential data regarding American business conditions. Investigations so far made disclose the astonishing fact that of the 250,000 business corporations in this country, over 100,000 have no income whatever, 90,000 make less than $5000 a year, while only 60,000 make over $5000. Among the measures which Mr. Hurley suggests as contributing to the solution of this undesirable situation is the standardization of cost systems, so that business men will have ready access to methods which, after comparatively brief application, will disclose their true condition. He points out other activities for the commission, all of them aimed at helping, and not harassing, business. Enough has been said, however, to indicate that the fears expressed have, so far at least, proved unwarranted.

Why Is Registration in Civil Engineering Decreasing?

ELSEWHERE in this issue are curves showing that the registration of students in civil engineering has fallen off markedly since 1910. While there are data regarding some Eastern schools, most of the curves relate to Middle Western colleges. Apparently, the causes, whatever they may be, are operating over a wide area.

At first thought one cannot but characterize the tendency as alarming. Any decrease is to be suspicioned, at least, as a sign of decadence. On the other hand, it may be an evidence of necessary adjustment to changed conditions.

So far, certainly, as the colleges are concerned, the tendency presages difficulties. Buildings and equipment in the older institutions are provided for double the number of students forecast for a time three years hence when the effect of the declining curves will be felt in all four classes. Faculties, too, have been developed to care for the larger numbers. Unless the curves soon change and tend upward again, faculty readjustments and idle educational plant are sure to follow.

Whether the tendency is so serious from the standpoint of the profession generally is open to question. Has not the supply of graduates in the past been larger than the demand? College professors say that it has not, but how then can one account for the very large numbers of engineering graduates who, with fresh diplomas or after a year or two of technical experience, desert engineering paths for sales and executive work? Moreover, if supply is not greater than demand, why are engineering salaries at a level which, justly or unjustly, has caused quite general complaint? If investigation should prove that the decrease in registration is an effort to approximate supply to demand, the condition should not cause disquietude.

The Engineering Record believes that one of the causes for the downward tendency is a clearer understanding on the part of young men to-day of the financial prospects in the engineering world. Ten and fifteen years ago the profession was over-boomed. Popular magazines carried stories about the marvelous achievements and handsome incomes of engineers. Electrical engineering then, too, was rounding out the first fifteen years of its wonderful development and carried young men to a high pitch of enthusiasm. The misunderstanding regarding the compensation of engineers was quite general. That condition has changed, and among the public at large it is now well understood that extraordinary financial returns are not to be looked for in engineering work.

Furthermore, other courses of strong appeal to young men have come to the fore or been developed within the decade. Prominent among these are the so-called business courses, which aim to put economic studies on a practical basis and to give the student a close insight into money, banking and corporation organization and management. With "big business" occupying the center of the stage of national life the attraction toward courses in business has naturally been strong.

Then, too, scientific agriculture has bounded to the front. The remarkable work of the Department of Agriculture and the publicity given to the possibilities in scientific farming have opened new vistas to farmers' sons and the boys of small communities, who formerly shunned farming on account of its drudgery.

These two causes—a truer understanding of the financial return in engineering and the popularity of new courses—are undoubtedly operating. There are probably others. They should be clearly understood and their relations to the problem as a whole fully developed. Only with all of the facts in hand can the significance of decreasing registrations be appreciated, and the proper remedy, if one is needed, applied. Manifestly it is not a question for the college professors alone. The profession at large has a vital interest. For this reason the Engineering Record invites its readers, in the colleges and out of them, to contribute their views on the subject.

Zuyder Zee Reclamation Postponed by War

ONE of the important engineering projects postponed by the war is the reclamation of the Zuyder Zee, plans for which have been discussed for 25 years. Two years ago a bill covering the reclamation work was prepared, with the intention ultimately of presenting it to the Parliament. It was necessary first to have it approved by the various departments of the Government which would be affected by the work or the new conditions created. All of the civil departments have approved the measure, but the war department, deeply engrossed in more immediate affairs, has been unable to get at the plan, though it has been in its possession for the past year. The reclamation of the Zee will make necessary the modification of present plans for the national defense and, consequently, nothing can be done until the war department has signified its approval of the measure.

For this reason alone the measure will probably be delayed. But financial considerations are entering, by reason of the European complication, which may mean the indefinite postponement of the project, even after the war is over.

The scheme as planned will cost 300,000,000 guilders (a guilder is valued at 40 cents), while the land reclaimed will have an area of 190,000 hectares (about 47,000,000 acres). While the whole amount of 300,000,000 guilders would not be needed at once, because the building program extends over many years, the expense of Holland's mobilization will for some time be a tremendous burden on a population of only 6,000,000 people. Until September Holland had expended 275,000,000 guilders on mobilization within its European limits, while 65,000,000 had been spent in a similar way in the colonies. Since then a 200,000,000-guilder war loan has been floated, and the expectation was that the total expenditure on account of military preparations would be about 600,000,000 to the end of 1915. If the war should last another year not less than 1,000,000,000 guilders would be spent. Considering that the purchasing power of a guilder in Holland is not much less than a dollar here, it will be seen that Holland must suffer an economic setback due to its enforced military program.

The problem, from the technical and economic standpoints, is an extraordinarily interesting one. Not only are there involved a tremendous mileage in inclosing dikes, huge locks to connect the canals with the sea, and large pumping stations, but economic problems of a very unusual sort. For example, the salt-water fishing industry now thriving there will be destroyed. It is expected that some compensation will have to be made to the interests affected. On the other hand, there will replace the salt-water fishing a fresh-water fishing industry of large proportions. This in turn will have to be evaluated, and consideration given to the extent by which it offsets the loss due to the destruction of the salt-water fishing industry. Again there are now on the shores of the Zee towns which have built up a considerable shipping business. Naturally these must retain their water communication facilities, so that an auxiliary canal system must be provided. Moreover, the construction problem is not so simple as levee building generally is in this country. A tremendous quantity of willows will be needed for mattress work, such quantities, in fact, as cannot be obtained immediately. It will be, necessary, therefore, to grow them expressly for the work. Likewise a supply of suitable levee-building material is a most troublesome one, clay being notably scarce in the Zuyder Zee district.

These technical difficulties, naturally, only serve in the present economic crisis to put off still longer the day when this most interesting engineering work will be put under way. Doubtless it will come eventually, but certainly not until the courageous little country on the North Sea has had an opportunity to recover in part at least from the draft on its resources which its part as a near neighbor of the fighting European nations has imposed on it.

Flaw in the Proposed Officers' Reserve Corps Bill

INSOFAR as it affects engineers, the proposed bill for the creation of an Officers' Reserve Corps of the regular army, as now drafted in a tentative way, contains one provision which will prevent the technically trained man of broad experience from offering his services as part of the plan for adequate national defence. This undesirable feature of the measure relates to the ages at which men may be admitted as reserves. The bill states: "No person shall be appointed or reappointed a second lieutenant in the Officers' Reserve Corps after he has reached the age of 32 years, a first lieutenant after he has reached the age of 36 years, a captain after he has reached the age of 40 years, or a major after he has reached the age of 45 years." The bill is not yet in final form and there is time for the joint committee of members of the five national engineering societies—civil, mechanical, electrical, mining and consulting—to use their influence in having this portion of the proposed legislation amended.

If this country should be called upon to defend itself from attack by a foreign power, engineers of all degrees of training would be urgently needed, but the bill, in its present form, would admit to service only the comparatively young men. They, of course, would fill a most important place. They could be used to best advantage in those duties requiring strong physiques, capable of enduring the most vigorous kind of service at the front.

Another group of engineers, however, would be of equal, if not greater service—the mature members of the profession, with judgment ripened by years of experience, the consulting engineers, chief engineers and department heads. The present age limitations would exclude them from the reserve corps.

The great asset which this group represents must not be thrown away. These are the men of broad executive experience, who would be able, for example, to take the War Department's plans for a series of large-scale defensive works, get contractors together, and push the work through expeditiously.

The present number of regular officers in the engineer corps of the army would be absurdly inadequate to cope with the manifold military engineering problems which a threatened invasion would present for solution. The weakness is not in training or efficiency, but in numbers. The corps must be reinforced in the event of a national crisis and any bill creating a reserve for this purpose should provide for using the senior members of the engineering profession as well as those under 45 years of age.

Chicago Electrification Report

THOUGH the committee on smoke abatement and electrification of the Chicago Association of Commerce after a four years' investigation has decided that electrification is too expensive and will contribute but slightly to smoke abatement, no one with confidence in the progressive spirit of Chicagoans and of the American people generally will believe that electrification is a dead issue in Chicago. Should any be inclined to take that view, the action of the Chicago City Council in directing its terminal committee, within a week after the presentation of the report, to study the problem would convince them that Chicago does not intend to take the report as final. There is good reason to believe, too, that within a comparatively short time at least two railroads, the Chicago & Northwestern and the Illinois Central, will be actively engaged in electrification work. In fact, the president of the Northwestern is reported to have said that the trackage of his road in Chicago would be electrified as soon as the money was obtainable. Nevertheless, general electrification of Chicago terminals has probably been postponed for some time, and that, undoubtedly, is what the railroads wanted. It is unlikely that the Chicago City Council will pass a mandatory ordinance, obliging all of the roads to abandon steam power. Some compromise measure may be put through, but at all events agitation for electrification will continue.

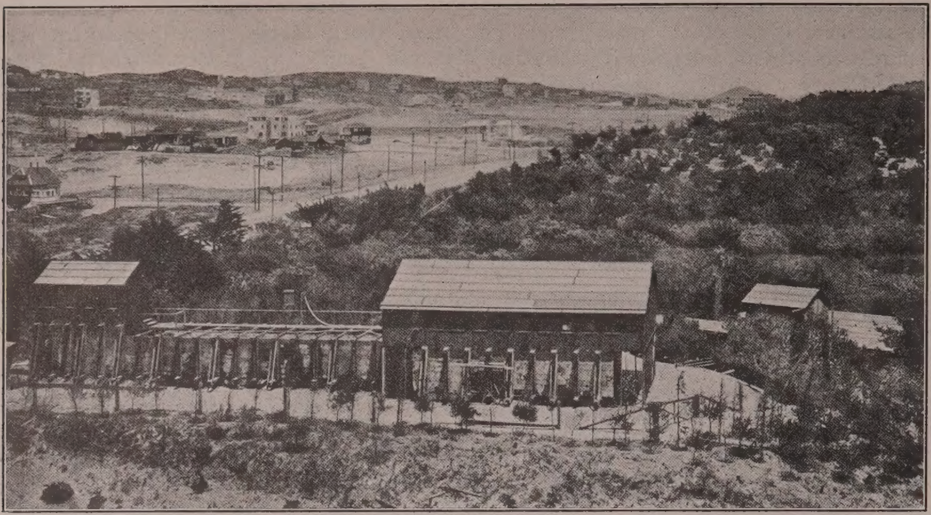
In reading the report, one is impressed strongly with the idea that the prevailing notion in the study was as to the effect of electrification upon the total volume of smoke produced. While this was the primary purpose in the appointment of the committee, its function, judging by the report itself, was evidently a broader one. It has, it is true, reported upon electrification as such, but in the background always there appears to be the relation of electrification to smoke abatement. That feature, too, is likely to induce many to accept, with little argument, the conclusions of the report negative to the electrification plan.

After finishing its discussion of electrification with reference to smoke abatement, the problem of electrification in itself—its effect upon operating expenses—is exhaustively studied. The second phase of the study, however, should not, it seems to this journal, have been the final one. There are benefits of electrification which should have been evaluated and which are too important to be lightly passed over. The report does recognize that there are "indeterminate results," such as increased capacity of terminals, greater reliability of electric than of steam operation, larger return from the use of railroad property, greater health, comfort and convenience for the public and a reduction of the loss and damage to property now occasioned by locomotive smoke. Relatively speaking, these may be indeterminate advantages, though as to that there is question, but certainly they deserve more than eight pages in an 1177-page report—and eight pages is all that is devoted to them.

If one wants tangible evidence of some of these advantages, it is readily procured by studying the conditions which recently obtained at the Grand Central Terminal, New York, and of the conditions there to-day. A district formerly cursed with locomotive fumes and gases, and constantly stirred by the ringing of bells and locomotive noises, remained, as does most property adjacent to railroads, backward and undesirable. Since the change, great hotels, fine apartment houses and clubs have been erected on the terminal site, while upper Park Avenue now displays an imposing group of the most expensive apartment houses in the city. Are the advantages in the probable appreciation of land values any less determinate than many of the scientific engineering problems which the committee had to consider? Moreover, is there any reason why such property appreciation should not help pay for the work by means of an assessment of benefits?

This brings up the further point that Chicago, so the committee states, cannot participate in the cost of electrification work. Chicago does participate, however, in the elimination of grade crossings within its limits. Are not benefits, comparable to those in the Grand Central Terminal section of New York City, public advantages just as much, though not of the same kind, as grade-crossing elimination? To admit that the constitution offers a permanent bar to a desirable civic improvement is an admission of weakness that the American public should not condone.

In sum, therefore, while the Engineering Record accepts the report as postponing for a time the general electrification of Chicago terminals, it believes that a great opportunity has been lost to show a broad vision of the relations between the railroads and civic development. It believes, too, that as a business proposition Chicago could well participate in the first cost of the work. The advantages upon which this journal lays emphasis are admittedly impossible of absolute determination, but so are many other important elements and results in every great engineering work. Dogmatize, if you can, regarding the value of a pure and adequate, as against a polluted and inadequate, water supply. Yet some appraisal is possible, and in a broad view of a great problem adequate place must be given these so-called "indeterminate" factors. They are no less important because relatively difficult to value, nor in the Chicago case are they necessarily so insignificant as not to change the conclusions of the report.



THE FILTER PLANT WAS SIX MILES FROM THE EXPOSITION GROUNDS

Wooden Filters Prove Economical for Temporary Exposition Water Supply

Expensive Construction Avoided at San Francisco by Designing Tanks and Basins as Timber Flumes—Operating Data and Costs

By E. C. EATON
Superintendent of Filtration Plant, Panama-Pacific International Exposition

BY SELECTING wood as the chief material of construction for the mechanical filtration plant at the Panama-Pacific International Exposition in San Francisco the designers were able to effect marked reductions in the cost of the works, which, because of their temporary service of only a few months during the life of the Exposition, did not warrant the larger expenditures which a permanent plant would have justified. This consideration, naturally, was responsible for a number of departures from ordinary practice in the design and construction of rapid filters. Among them are a simple but novel underdrainage system using a high velocity of wash water without air; an automatic control of the coagulant in proportion to the flow of water, and the use of timber flume construction for the several tanks of the plant. Most of the raw water is secured from deep wells, which caused a good deal of trouble with sand, but the plant proved adequate for the Exposition's needs. More detailed information on the well pumping troubles will be found in the "Hints for the Contractor" section, page 769.

SOURCES OF SUPPLY

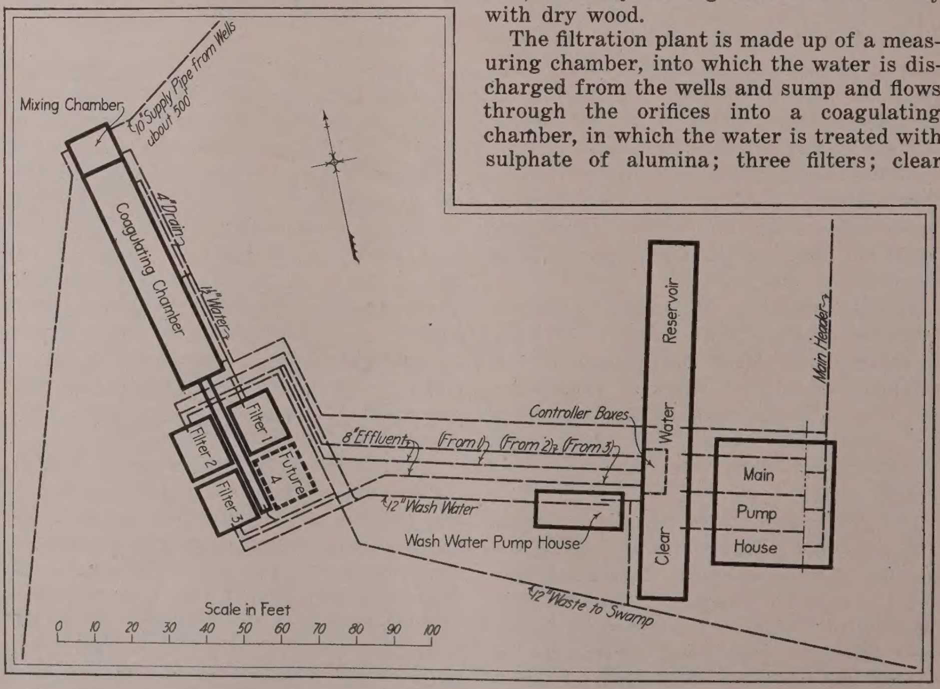
Water for the Exposition was secured from several sources—a sump 200 ft. long, 14 ft. wide and 30 ft. deep in Golden Gate Park; five wells averaging 82 ft. in depth, and from the Government and Spring Valley Water Company's supplies. An estimate of the available average daily yield is given in Table 1.

The estimated daily requirements of the Exposition were from 1,400,000 to 2,500,000 gal., based upon data obtained during the pre-Exposition period. Analyses of the water made in May, 1914, from the North Windmill sump and from an old sump known as Rolandi's, in Golden Gate Park, gave the following results: *North Windmill sump*, bacterial count 110 per cubic centimeter, and B. coli not detected in 1 cu. cm.; *Rolandi's sump*, bacterial count 850 per cubic centimeter and B. Aerogenes present in 1/1000 cu. cm. Both bacterial and sanitary analyses indicated that the water should be carefully watched and, therefore, a filtration plant was decided upon.

TABLE 1—AVAILABLE AVERAGE DAILY YIELD

Source	Yield, gal. per day
Sump in Golden Gate Park............	350,000
Wells—5 wells at 260,000 g.p.d. each when operated alone, capable of the yield per day multiplied by 2¾ times..	650,000
Spring Valley Water Company..........	150,000
Wells on Exposition grounds...........	150,000
Presidio (Lobos Creek)................	800,000
	2,100,000

The site of the proposed plant was approximately 6 miles from the Exposition grounds, and to reach this an elevation of 365 ft. had to be crossed. At the summit of this elevation, and distant 19,300 ft. from the plant was the 6,000,000-gal. storage reservoir of the Government's Lobos Creek plant. This reservoir is divided by a concrete retaining wall and one half set aside for Exposition purposes.



RELATION OF THE SEVERAL PARTS OF PLANT AND ARRANGEMENT OF PIPING

The Exposition waterworks system consisted, in brief, of a sump and five deep wells delivering water to a filtration plant; a main pumping plant, pumping water through a 12-in. steel pipe line to a height of 365 ft., a distance of 19,300 ft.; a reservoir of 3,000,000 gal. capacity, and a gravity pipe line to the Exposition grounds, 5,200 ft. long.

FILTERS OF WOOD

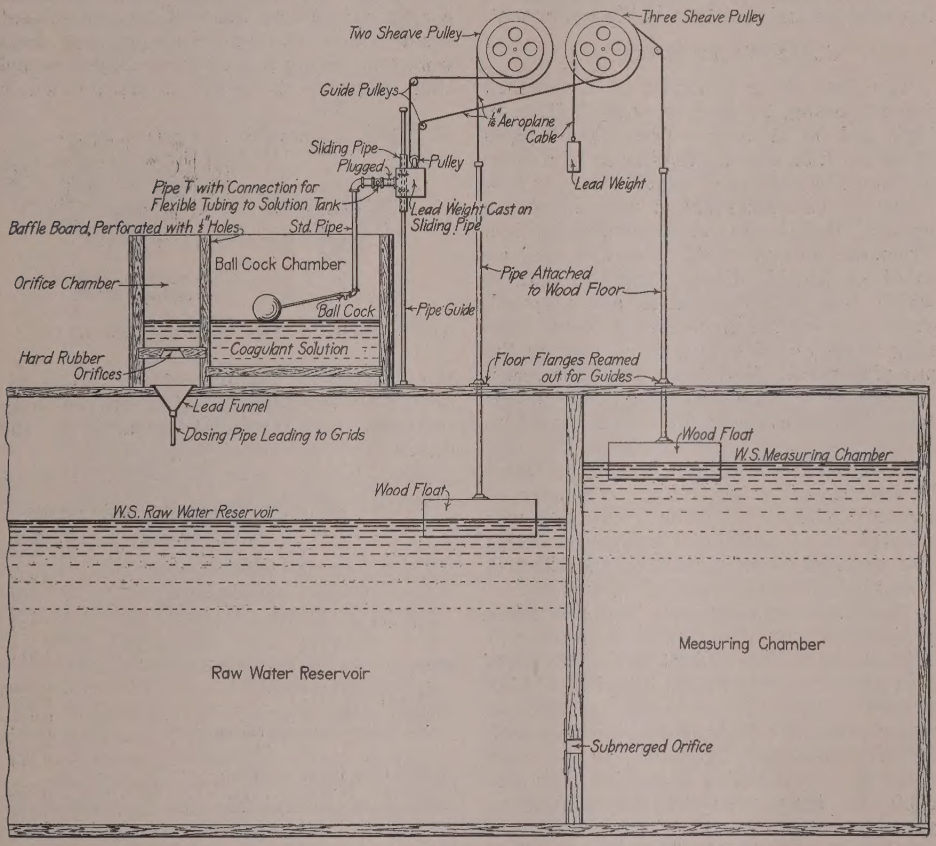
Owing to the temporary nature of the filter plant, a timber flume structure was decided upon, having a uniform framing throughout. The side posts are composed of two 3 x 6-in. timbers, bolted to 4 x 6-in. sills, having side blocks bolted on the sills to take the thrust from the side posts. The side posts are similarly bolted to a 4 x 6-in. cap. The standard spacing between side posts is 4 ft., and every third post is braced with two 2 x 6-in. braces. The whole flume rests on five 6 x 12-in. stringers, under which 8 x 12-in. mud sills are placed, resting on 3 x 12-in. plank.

In the wooden tanks or flumes a spline joint was used, having specially tapered grooves cut in the edges of the 3-in. plank, into which the splines of kiln-dried fir were placed, these splines being a driving fit. A good deal of discussion took place as to whether or not the splines and edges of the plank lining should be given a coat of asphaltum, with the result that one of the structures, the raw water flume, was left untreated, while the clear water reservoir was painted with asphaltum on the joints. The results show that the untreated splines made eventually the more watertight joint. It has been the writer's experience, covering a good deal of flume and wood-pipe work, that no better joint can be made in timber structures intended to be watertight than the clean wood to wood joint, allowing the free swelling of the wood throughout; also, that any calking should be done only with dry wood.

The filtration plant is made up of a measuring chamber, into which the water is discharged from the wells and sump and flows through the orifices into a coagulating chamber, in which the water is treated with sulphate of alumina; three filters; clear water reservoir; and a main pump house containing units, which raise the water to the main reservoir supplying the Exposition.

MEASURING CHAMBER

The measuring chamber is formed by bulkheading off one end of the coagulating chamber, thus forming a chamber 12 ft. 6 in. wide, 9 ft. 6 in. long and 9 ft. 3 in. high. Through this bulkhead two submerged orifices 4 in. high and 12 in. long are cut; over them bevel-edged plates are fastened. The pipe lines from the sump and deep wells discharge through openings in one end of this chamber. These discharges are provided with a simple type of float valve, operated by a light cable from floats in the raw water reservoir, the height of water thus being maintained constant.



DIFFERENTIAL EQUIPMENT FEEDS COAGULANT SOLUTION AUTOMATICALLY IN PROPORTION TO FLOW OF WATER

The coagulating basin consists of a flume structure 12 ft. 6 in. wide, 8 ft. high and 64 ft. long, into one end of which the water is discharged from the measuring chamber, and at the other end is taken out by a small supply flume 2 ft. wide and 3 ft. high, running between the rows of filters. Ten-inch shear gates are fitted over openings cut in the sides of this flume, admitting water to the three filters.

FILTER STRAINERS UNIQUE

There are three filters, each capable of filtering 500,000 gal. of water per day. In construction each consists of a section of flume framing 12 ft. 6 in. wide, 8 ft. deep and 14 ft. 8 in. long, with a bulkhead at each end, forming filter units of 183 sq. ft. surface each. At the rate in general use in filters of this type—2 gal. per square foot of sand surface per minute—this gives a capacity per filter of 366 gal. per minute, or over 500,000 gal. per day per filter.

The strainer system has for its advantage extreme simplicity, low cost and successful operation, and is a design developed by Prof. Charles Gilman Hyde, of the University of California. In the upper side of the header openings are provided, to which 3-in. nipples are cemented, connected to 2½-in. tees, in which lateral pipes are screwed. The 2½-in. lateral pipes are spaced 6 in. on centers, and have 5/16-in. holes drilled on the underside on 3-in. centers.

Four graded layers of gravel were put in above the strainer system, as follows:

Layer 1—From bottom of filter to 2 in. above the tops of the lateral pipes, clean gravel of such a size that it was retained on a circular opening 1½-in. in diameter and passed a 2½-in. opening.

Layer 2—Above layer 1 and 3 in. deep gravel passing a 1½-in. opening and retained on a ¾-in. opening.

Layer 3—Three inches deep, gravel passing a ¾-in. opening and retained on a ¼-in. opening.

Layer 4—Three inches deep, gravel passing a 4-mesh sieve and retained on a 12-mesh sieve. Above this was placed the filter sand, 26 in. deep, having an effective size of 0.35 mm. and a uniformity coefficient of 1.5.

A grade of sand was located about 60 miles from San Francisco which was admirably suited for the purpose. In size this was somewhat finer than it is now the practice to use in filtration plants, as bacterial efficiency of filtration was the important consideration, the water containing very little turbidity. Above the sand, provision is made for a 30-in. head of water. The filter effluent is carried by gravity through 8-in. pipes to the controller chambers in the clear water reservoir.

The filters are controlled at the filtered water reservoir. A simple type of controller was designed, consisting of a special casting containing a vertical piston. A walking beam and wood float operate the valve from full open to closed positions in a 2-in. travel of the float. Ordinary wood floats dipped in hot asphaltum were used, and have proved entirely satisfactory, and as sensitive as required. An auxiliary float is provided in the clear water reservoir, so that, in case the water rises too high in the reservoir, the controllers are shut off until the water again reaches a lower level.

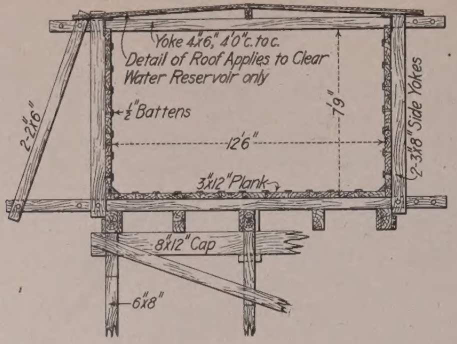
Through each controller chamber and located 12 in. above the bottom of the chamber a submerged orifice is cut by which the water passes from the chamber to the clear water reservoir. As the controller maintains, within a margin of 1 in., a constant head of water in the chamber, and as the main pumps are regulated to keep a constant level in the clear water reservoir, there is a practically constant difference of head over this orifice, thus keeping a uniform rate of flow from each filter. The filters will, of course, "respond to the pumps," until a prearranged maximum rate per acre daily is reached.

A loss-of-head gage is installed at each filter, consisting of a glass tube 6 ft. long, and connected to the effluent pipe just after leaving the strainer header. This is provided with a gage board graduated in feet and tenths. The loss of head with filter running at full capacity and sand clean is 1.7 ft., and, under ordinary conditions of service, reaches a value of 6 ft. in from 10 to 15 hr., at which point the filters are washed.

WASH WATER SYSTEM

In almost all the filtration plants in operation to-day a combined air and wash water system is installed, the air performing the function of keeping the sand stirred up while the water cleanses it. It was believed that a considerable saving would be effected by using a high velocity wash water system and doing away with the air. A 10-in. centrifugal pump was installed in a separate house located close to the clear water reservoir, from which the suction pipe runs. The rate of washing employed is a 2-ft. vertical rise per minute. The time required for actual wash is 2 min. and a 1-in. flow over the weir edges of the troughs is maintained by the wash water. At this rate of washing the sand is raised bodily 12 in. and kept in motion, while the wash water passes up through the whole. For the purpose of collecting the wash water two V-shaped wood troughs, 24 in. wide by 18 in. deep, were built longitudinally over the filter. The weir edge is 2 ft. above the sand level. The troughs discharge the wash water through a 16-in. shear valve into a 12-in. drain, which terminates in a slough near the plant.

The total quantity of wash water used for the month of June was 692,000 gal., or 2.1 per cent of the total quantity pumped, and gave an average run per filter between washes of 15 hr. A considerable saving has been effected by using the high velocity wash water system instead of the older air and water system. Records of plants employing the latter system show that a column of water 6 ft. high is required, the rate being 7 gal. per square foot of sand surface per minute. By using a rate of 15 gal. per square foot per minute a 2-ft. column only is required, thus saving 2700 gal. per wash, as well as a considerable amount of time. In this connection, how-


Yoke 4"x6", 4'0" c. to c.
Detail of Roof Applies to Clear Water Reservoir only
½" Battens
7'9"
12'6"
2-3"x8" Side Yokes
2-2"x6"
3"x12" Plank
8"x12" Cap
6"x8"

TIMBER FLUME CONSTRUCTION REDUCED COST OF TANKS AND FILTERS

ever, it should be remembered that this plant operates with a water which contains no appreciable amount of clay. No wire screens have been used over the gravel and below the sand, and no appreciable disturbance of the gravel was noted on examination after the filters had been in operation a month.

COAGULANT

The equipment for dosing the water is located in a house built directly over the measuring chamber and consists of the mixing tanks, orifice box and their piping, and the dosing grids. The two mixing tanks, of 500 gal. capacity each, are located on a platform above the floor of the house. Fastened to the inside of each of these tanks is a semicircular wooden box, with a removable galvanized iron screen for a bottom. Over the top of this chamber is located a distributor, consisting of a 1½-in. galvanized iron pipe perforated on the underside with ⅛-in. holes. The operation of mixing a stock solution is carried out by putting a weighed quantity of sulphate of alumina crystals into this compartment and allowing the water from the distributor to spray over it.

In the bottom of each of the mixing tanks is located a grid of ¾-in. pipe, perforated with 1/16-in. holes, connected to a No. 3 Roots blower run by a ½-hp. motor. This is operated for a few minutes every 3 hr. and keeps the solution well stirred. From the bottom of the tanks 1½-in. pipes are run, terminating in a ball-cock located in the orifice box, which maintains a uniform head over the orifices.

At one end of the box are located the orifices, two 3-in. hard-rubber disks, in each of which is a ¼-in. hole, through which the solution is admitted to the water, the quantity, of course, being proportional to the head over the orifices.

The solution falls from the orifices into a lead funnel connected to a 1¼-in. pipe running down the center of the raw water reservoir and above the water surface. A tee is located every 12 ft. in this pipe, from which a pipe extends to 12 in. below the water surface, having a ¾-in. pipe running across the reservoir. On the underside of this pipe are drilled ¼-in. holes on 6-in. centers. The whole forms a set of distributing grids, by means of which the coagulant solution may be admitted, at chosen points, to give the required period of coagulation, allowing a partial forming of the floc before entering the filters.

In order that the coagulant system should be as nearly automatic as possible a simple differential equipment was installed to alter the level of the solution over the coagulant orifices in proportion to the quantity of water flowing from the measuring chamber into the raw water reservoir. As this flow is proportional to the difference in height of the water in the measuring chamber and raw water flume, a wood float was placed in each of these, to which a 1-in. pipe was attached, passing through the floor. The ends of these rods were connected to a 1/16-in. aeroplane cable, each terminating in a drum. This drum was provided with a smaller sheave, to which another section of cable was attached, which imparts a raising or lowering motion to the ball-cock mechanism in proportion to the alteration in levels in the raw and measuring chambers. The equipment has worked satisfactorily throughout and requires no attention except the mixing of the solution and cleaning of the equipment.

CLEAR WATER RESERVOIR

The clear water reservoir is of standard flume framing, 12 ft. 6 in. wide, 7 ft. 6 in. high and 96 ft. long. The effluent pipes from the filters each terminates in a compartment in which are located the rate controllers. The reservoir is roofed over to protect the water from contamination. From the bottom of the reservoir, and located on the side directly opposite that on which the controller boxes are situated, three 6-in. suction pipes are taken out, running to each of the three main units in the pumping plant. Over the part of the reservoir containing the controllers a house was erected which contains the sterilizing equipment.

Although the treatment given the water by the filters has been found to remove all contamination, a chlorine treatment was adopted as an additional safeguard. This was supplied as an exhibit by the Electro-Bleaching Gas Company, of New York.

The main pumping plant contains three 5-stage, 6-in. turbine pumps, each rated at 500 gal. per minute under 220 lb. per square inch pressure, 1550 r.p.m., belted to 125-hp. motors. These pumps send the filtered water through a 12-in. steel pipe line, with Dresser couplings, 19,300 ft., to the main reservoir, from which a gravity pipe line 5200 ft. long runs to the Exposition grounds.

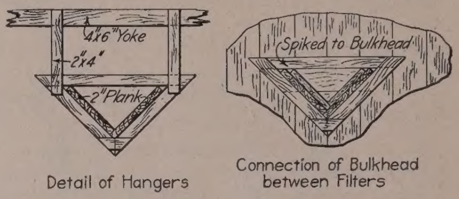
Up to July 7 the plant was not required to run at its full capacity. The main reservoir holds a little over a day's supply and the water pumped over is, therefore, regulated by the demand at the grounds.

COSTS

The actual costs of operating the plant for the month of June are given in Table 2.

Aluminum sulphate containing 17¼ per cent Al_2O_3 cost $1.75 per 100 lb., delivered at the plant in lots of thirty 250-lb. sacks. Chlorine cost 14 cents per pound, including freight both ways on cylinders, from and to Niagara Falls, N. Y.

It was found by trial that a dose of aluminum sulphate of 1 grain per gallon of water to be filtered, combined with a coagulating period of 30 min. before the treated water was admitted to the filters, produced a very satisfactory floc and gave an effluent from which all contamination had been removed. Using a very much longer period than this caused the floc to settle down in the coagulating chamber before it was admitted to the filters, and a heavier dose required more frequent washing of the filters.



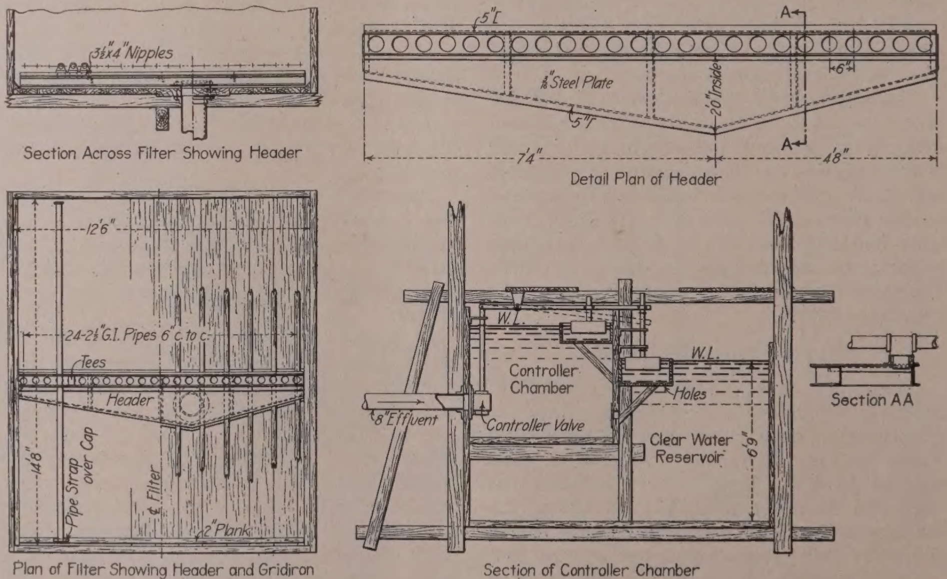
Detail of Hangers

Connection of Bulkhead between Filters

WASH WATER TROUGH DETAILS

TABLE 2—COSTS OF OPERATION PER THOUSAND GALLONS

	Cost in cents
Pumping from deep wells:	
Power	0.846
Operators and superintendence	.607
Repairs to pumps	.047
Oil and grease, waste, etc	.017
	1.517
Filtering and treating water:	
Sulphate of alumina	0.250
Chlorine	0.056
Wash water	0.045
Operators and superintendence	0.623
	0.974
Pumping to main reservoir:	
Power	3.300
Operators and superintendence	0.631
Oil, waste, etc	.004
	3.935
Total cost per 1000 gal	6.426



Section Across Filter Showing Header

Detail Plan of Header

Section AA

Plan of Filter Showing Header and Gridiron

Section of Controller Chamber

FILTER UNDERDRAINAGE SYSTEM IS NOVEL; EFFLUENT CONTROLLER CONSISTS OF WOODEN FLOATS AND WALKING BEAM DEVICE

The dose of chlorine used is 3 lb. per million gallons of water treated, or an equivalent of 21 lb. of hypochlorite per million gallons.

Tests of the water were made at weekly periods by the federal laboratory, under the supervision of Dr. C. C. Pierce, chief sanitary officer of the Exposition. In no case has contaminated water been discovered in any of the tests made at the reservoir. Analyses of the raw water show very little variation and the following is a representative test: Raw water—Gas in 10 cu. cm. Colon types; count 100 per cubic centimeter. Effluent—Gas in none of the specimens; count 12 per cubic centimeter.

The filtration plant and first five wells were constructed by contract; the costs are given in Table 3.

TABLE 3—CONSTRUCTION COSTS

Filtration plant, including deep wells and main pump houses and pipe lines, but exclusive of cost of wells and pumps...		$14,575.00
First 5 wells, at $7.50 per foot...........		3,075.00
Pumps, consisting of three 5-stage main pumps; one vertical centrifugal sump pump; five deep well turbine pumps; one wash water pump................		4,962.00
Well No. 6 (drilled by Exposition Company):		
Casing	$159.25	
Gravel filling 2.8 yd. at $2......	5.60	
Cement, 0.32 bbl. at $2.75......	.88	
Labor	70.00	
		235.73
Per lin. ft., $3.89.		

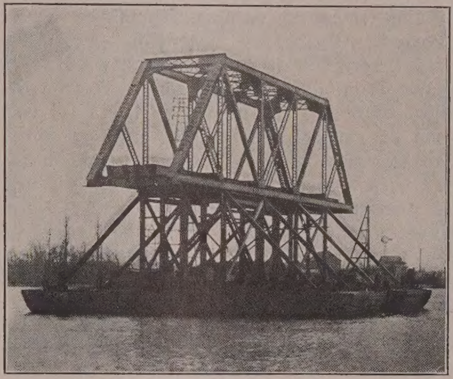
The estimates of available supply and Exposition requirements and investigations as to the use of Lobos Creek and the vicinity of Golden Gate Park as a source of supply were made by A. H. Markwart, assistant director of works. The successful design, construction and operation of the system is the result of co-operatin between the civil and mechanical engineering departments of the Exposition Company, under G. L. Bayley, chief mechanical and electrical engineer, and E. E. Carpenter, chief civil engineer. The services of Prof. Charles Gilman Hyde were secured in a consulting capacity in connection with the design of the filtration and water purification plant. Surveys and other preliminary work, together with construction of the sump, first wells and main pipeline, were under the direction of C. C. Blee. The design and construction of filtration plant, construction of new wells and operation of the system were under the supervision of the writer.

THE PRACTICE OF MAKING DIRECT SURVEYS by parties made up of regular employees of the U. S. Department of the Interior, instead of by contract with private surveyors, as was the practice for half a century, has been in operation two years and, according to an announcement of the department, has resulted in greater accuracy and efficiency. In all, there are 150 surveying parties so employed.

Bridge Spans Moved Bodily to a New Site

Canadian Pacific Railway Bridge Across Pitt River Was Purchased by the Provincial Government and Moved to Site Where New Highway Crosses the Stream

When the Canadian Pacific Railway replaced its single-track bridge over the Pitt River in British Columbia with a double-track structure, the provincial government officials saw a chance to expedite greatly the completion of the proposed highway which parallels the railroad at this point, and accordingly opened negotiations for the purchase of the railroad bridge. A mutually advantageous agreement was made, and while piers for the highway bridge were being constructed about 200 yd. upstream, the seven spans of the railroad bridge were placed on temporary pile supports along the bank of the river.



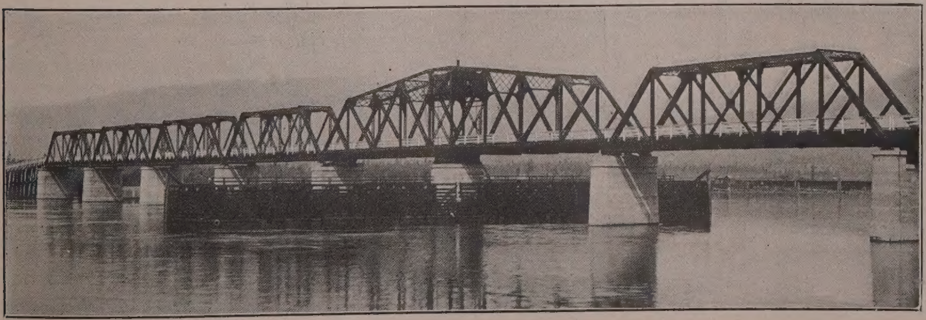
ONE OF THE SPANS EN ROUTE

When the new piers were ready the steel spans were one by one floated on barges, towed to the new site and lowered carefully into place on the piers. Under this plan a steel bridge 2059 ft. long, including nine concrete piers, with a drawspan and pivot pier, was completed and placed in service in several months less time than would have been possible if spans had been fabricated to order. Of course the piers had to be designed and spaced to suit the spans, and are probably closer together than would have been the case for a bridge built for the lighter traffic. However, this was more than made up for in the lower cost of the superstructure and the time saved.

The spans were moved from temporary supports to the new piers by barges on which timber framework had been built up to carry the spans at the proper height. The barges were equipped with seacocks by means of which water could be admitted, causing them to settle to a lower level in the water. When a span was to be moved the barges were partly filled with water before being placed beneath it, and the water was then pumped out, causing the barge to rise gradually and assume the weight of the steelwork. The spans were allowed to settle in place by simply opening the seacocks after the barges had been properly placed at the new piers.

Nine new piers were built at the new site, most of which were 37 x 20 ft. in plan, the pivot pier for the draw span being of octagonal shape with a diameter of 28 ft. Four of the piers were 90 ft. or more in height, but all were sunk by dredging in open caissons. The total amount of concrete required was 19,180 cu. yd. The total weight of the steel in the seven spans was 1,098.43 tons.

The contract for the construction of the piers and the moving of the steel spans was held by Armstrong, Morrison & Company, Ltd., of Vancouver, B. C.



FORMER RAILROAD BRIDGE IS NOW IN HIGHWAY SERVICE

"Cubic Performance"

A Term Intended to Designate the Rate of Volumetric Work Done by Sewage and Water Treatment Devices

By **LESLIE C. FRANK**
Sanitary Engineer, U. S. Public Health Service

The purpose of this paper is to present and to define the term "cubic performance," which has been devised in an attempt to express the rate of volumetric work done by sewage and water treatment devices in such a manner as to be independent of any particular volumetric unit.

There is at present no term in general use which gives a simple, comparative picture of various sewage or water treatment devices from the standpoint of volumetric rate of work done. In comparing one Imhoff tank with another it is often customary to state the relative sedimentation periods, the relative sludge storage periods, and the relative sludge supernatant volumes. Such a comparison involves a simultaneous mental co-ordination of six terms, obviously awkward. Or, if it is desired to compare volumetrically an Imhoff tank with an activated sludge tank, the Imhoff tank would be described by stating the sedimentation period, the sludge storage capacity and the sludge supernatant capacity, while the activated sludge tank would be described by stating the oxidation period and the sedimentation period. The difficulty of co-ordinating so many factors simultaneously is apparent.

It is necessary for certain purposes, of course, to know the various factors, but for convenience of stating the volumetric rate of a device as a whole these factors ought to be combined in such a manner as to result in a single expression. The term "cubic performance" is offered as such a single expression.

"CUBIC PERFORMANCE" DEFINED

The cubic performance of any sewage or water treatment device may be defined as the number of unit volumes of liquid treated per unit volume of device in a unit of time. The unit of time selected is arbitrary, but it is believed that two particular units of time would be most serviceable—the day and the year. The daily cubic performance, for example, of a sprinkling filter 8.5 ft. deep, dosed at the rate of 2,500,000 gal. per acre per day would be the number of gallons of sewage treated daily on an acre divided by the number of gallons of filtering material represented by an acre; or:

$$2{,}500{,}000 \div (7.48 \times 43{,}560 \times 8.5) = 0.9$$

That is, the sprinkling filter in question will treat sewage at the rate of 0.9 its own volume per day.

Again, an Imhoff tank with a mean detention period of 2 2/3 hr., a sludge storage capacity of 1 cu. ft. per 100 gal. of sewage per day, and a sludge supernatant volume of 0.5 cu. ft. per 100 gal. of sewage per day, would have a daily cubic performance of 4.48. This is derived as follows: 100 gal. of sewage in 24 hr. is equivalent to 11.1 gal. of sewage in 2 2/3 hr., so that for each 100 gal. of sewage per day there must be provided a sedimentation capacity of 11.1 gal. or 1.49 cu. ft., which, with the added volumes for sludge storage and supernatant gives for every 100 gal. per day a total tank volume of $1.49 + 1.0 + 0.5 = 2.99$ cu. ft. As 100 gal. equals 13.4 cu. ft. the daily cubic performance is:

$$13.4/2.99 = 4.48$$

The daily cubic performance of a plain post-filter sedimentation tank with separate sludge digestion chambers is computed as follows: Given a mean sedimentation period of 2 2/3 hr. and a separate sludge storage capacity of 0.5 cu. ft. per 100 gal. of sewage per day. The volume of tank, per 100 gal. of sewage per day, for sedimentation and sludge digestion purposes is, as previously shown, $1.49 + 0.5 = 1.99$ cu. ft. The daily cubic performance of the post-filter system, therefore, would be:

$$13.4/1.99 = 6.74$$

Devices in Series

The daily cubic performance of any group of devices through which sewage flows in series is the reciprocal of the sum of the reciprocals of the individual performances. This relation will be obvious when it is remembered that daily cubic performance means "volume of sewage per day per volume of device" and that the reciprocal of daily cubic performance means "volumes of device per volume of sewage per day." Hence the addition of the individual reciprocals will give total volumes of devices per volume of sewage per day, which is naturally the reciprocal of the daily cubic performance of the series of devices. To illustrate the daily cubic performance of sewage devices acting in series assume a sewage treatment plant which makes use of Imhoff tanks, sprinkling filters and plain post-filter tanks with separate sludge digestion, all of these devices having the same characteristics as the examples previously discussed. The individual daily cubic performances are: For the Imhoff tanks, 4.48; for the sprinkling filters, 0.9; and for the post-filter system, 6.74. In accordance with the above rule, therefore, the combined daily cubic performance of these devices operating in series will be:

$$1 \div (1/4.48 + 1/0.9 + 1/6.74) = 0.675$$

In other words, the above sewage treatment plant, considered as a whole, will treat 0.675 of its own volume of sewage per day.

Devices in Parallel

The cubic performance of sewage devices acting in parallel will equal the reciprocal of the sum of the individual cubic performance reciprocals, each weighted according to the proportion of total flow taken by it. For example, if a given sewage treatment plant consists of Imhoff tanks having a daily cubic performance of 4.48 and plain sedimentation tanks with separate sludge digestion having a daily cubic performance of 5.35, operating in parallel, the plain sedimentation tanks taking 0.8 of the flow and the Imhoff tanks 0.2 of the flow, the combined daily cubic performance will be derived as follows:

$$1 \div (0.2/4.48 + 0.8/5.35) = 5.13$$

In other words, operated in parallel, with the total sewage flow divided as above stated, the combined sedimentation and sludge digestion system in question will treat 5.13 times its own volume per day.

Relation of Cubic Performance to Mean Detention Period

Cubic performance is the reciprocal of mean detention period, if the mean detention period be expressed in the same unit of time in which cubic performance is expressed. By mean detention period is meant here the detention period which will result from dividing the total effective inside volume of the device by the total volume of sewage treated per unit of time. For example, a plain sedimentation chamber with a mean detention period of 3 hr., or one-eighth of a day, will treat eight times its own volume of sewage per day and hence have a daily cubic performance of 8, i. e., the reciprocal of the nominal detention period.

Relation of Annual Cubic Performance to Cost Data

The term annual cubic performance which, of course, is 365 times the daily cubic performance, bears a simple relation to the cost of treatment of water or sewage. The total volume of any device multiplied by its annual cubic performance gives the total amount of liquid treated by the device annually. Therefore, the cost of treating a unit volume of liquid will be the total annual operating expense and capital charges of the device divided by VP_a, V representing the total inside volume of the device and P_a representing its annual cubic performance.

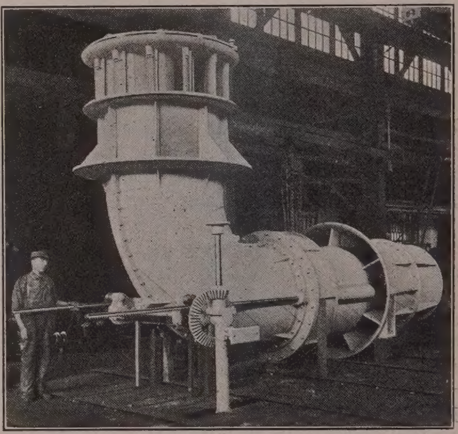
If it be desired to compute the volume of sewage treatment plant required for a given sewage flow and for a given type of plant it is necessary simply to divide the sewage flow per day by the daily cubic performance of the type of plant selected. The result will be the volume of plant required expressed in the same unit of volume used in expressing the daily sewage flow. The arithmetic of the relation is obvious. It may be used conveniently in approximate preliminary estimates.

In presenting the expression "cubic performance" there is no intention of *replacing* such terms as "sedimentation period," "sludge capacity," "sludge supernatant capacity," etc. The term is intended to act merely in a supplementary or embrasive sense. A particular field of application will be found in experimental work. It is being used, for example, in studies of the United States Public Health Service upon the new method of sewage treatment by means of activated sludge, and it is proving easy, thereby, to keep clearly in mind at all times the volumetric relation of this process of sewage treatment to other processes.

Discharge Accelerators Increase Power at Low Head

Device Utilizes Surplus Run-Off When Rising Tail-Water Cuts Down Power

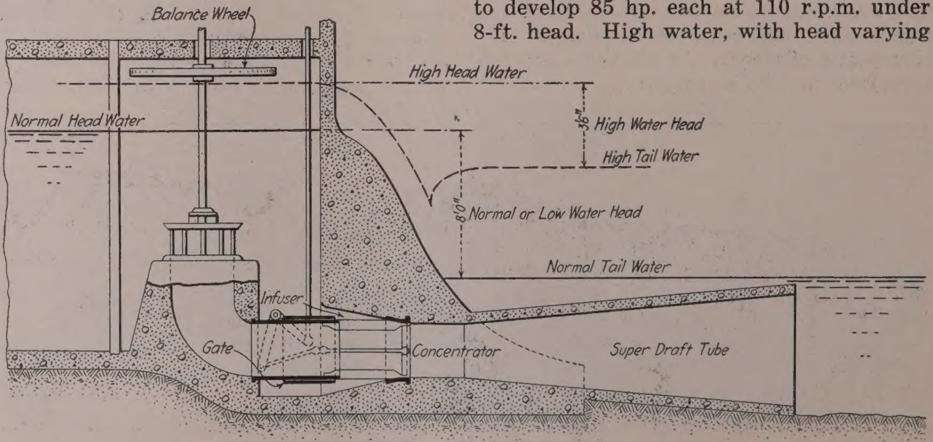
TURBINE discharge accelerators, so called, built into the draft tube of waterwheels at the Henry Ford farms, Dearborn, Mich., have shown a considerable increase in power during low-head conditions. A wheel giving 90 hp. under an 8.25-ft. head, without the accelerator in service, developed 116 hp. at 6.94-ft. head with the accelerator in operation. These data and a general description of the apparatus were presented by Mark A. Replogle of Akron, Ohio, in a paper read before the annual meeting of the American Society of Mechanical Engineers in New York last week.



INFUSER AND TURBINE ERECTED IN SHOP

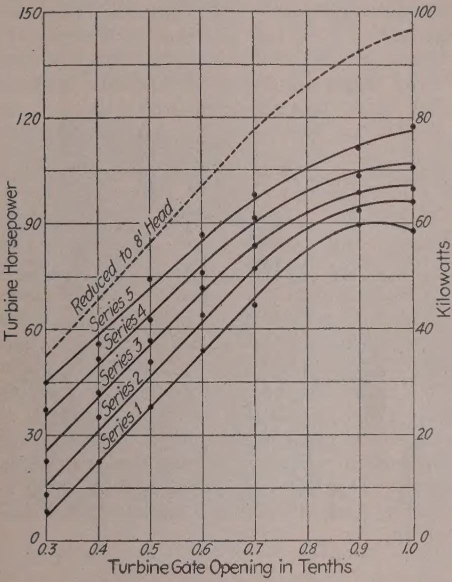
Plant

The accelerators are installed in a power plant which contains two turbines designed to develop 85 hp. each at 110 r.p.m. under 8-ft. head. High water, with head varying



CYLINDRICAL GATE CONTROLS AMOUNT OF ACCELERATING WATER USED from 2 ft. to 5 ft., may obtain for weeks at a time, so that provision to meet this condition was necessary. The accelerator design was accordingly developed. The general features of the apparatus are shown in two illustrations herewith. The purpose of the accelerators, evidently, is to transfer energy from surplus water, otherwise running over the dam and being wasted, to the turbines, augmenting their power under subnormal heads, after they have reached their normal power at those heads.

It will be noted from the illustrations that each accelerator consists of a superdraft tube, a concentrator and an infuser. The infuser is provided with a gate, by means of which the quantity of accelerator water may be varied at will, or shut off entirely.



POWER OBTAINED WITH DIFFERENT TURBINE AND ACCELERATOR GATE OPENINGS

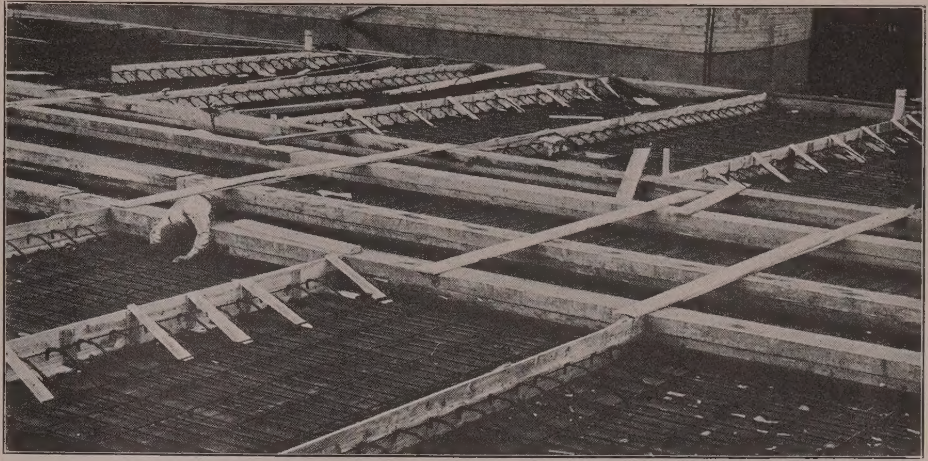
Series 1—Accelerator gate closed. Series 2—Accelerator gate open 20 per cent. Series 3—Accelerator gate open 40 per cent. Series 4—Accelerator gate open 60 per cent. Series 5—Accelerator gate open 80 per cent.

RESULTS

The curves shown are plotted from tests made on one of the accelerators. The increase in power with wider opening of the accelerator gate is apparent. In series 4, though the power increased, the accelerator was sucking air. This sucking continued in series 5, though in that test, too, the power increased. The excessive taking in of air prevented the further opening of the accelerator. The curve in series 5 shows that 116 hp. was developed at 6.94-ft. head. This curve, reduced by formula to an 8-ft. head, shows that 143.5-hp. can be obtained by the use of the accelerator from an 8-ft. head in connection with the identical turbines that have been guaranteed to develop only 85-hp. with this fall.

No attempt was made to measure the accelerator water used, though it is intended to make investigations during which this factor will be observed.

CHARTED COST DATA IN DAYTON are kept on many of the city's activities for the use of the lay workman. After plots of the amounts of certain supplies used for the same purpose by several men in a department were posted, automatically the curves of the careless users soon dropped to a normal figure.



FORMS FOR CASTING ALTERNATE 10-FOOT BAYS—STEEL RODS SECURELY HELD

New South Brooklyn Pier at Thirty-fifth Street Is the Longest in New York

Work Is Progressing on Structure 1740 x 175 Feet with Railroad Tracks Placed Outside the Shed on Each Side

THE design of the Thirty-fifth Street, Brooklyn, pier, in New York City, differs from the usual type in this vicinity in the fact that the company which will lease the pier from the city desired the railroad tracks to be placed at the sides of the pier rather than in the center. This required about 25 ft. greater width than the center-track type, at an added cost of nearly $50,000. The advantages claimed are in the possibility of direct transfer from ship to cars, which the Luckenbach Steamship Company, Inc., the lessee, claims its cargo shipping system will make possible.

The provisions for cargo hoists are typical of those adopted in New York pier construction as the most efficient and simple device for handling the packages of variable sizes and shapes which must be transferred from ship to truck or car. Details of the cargo cables and high steel cargo columns used in this system are shown, and the general design of the substructure and the steel pier shed illustrated.

GENERAL DIMENSIONS AND LOCATION

The pier, 1740 x 175 ft., is the longest in New York City. The shed is nearly 140 ft. wide, and the tracks are placed outside the shed, one on each side as shown in the typical half-section. The floor slabs of reinforced concrete span 10 ft. between the transverse rows of piles. The added loads from the light one-story shed columns are provided for by increasing the number of piles, as indicated on the plan views.

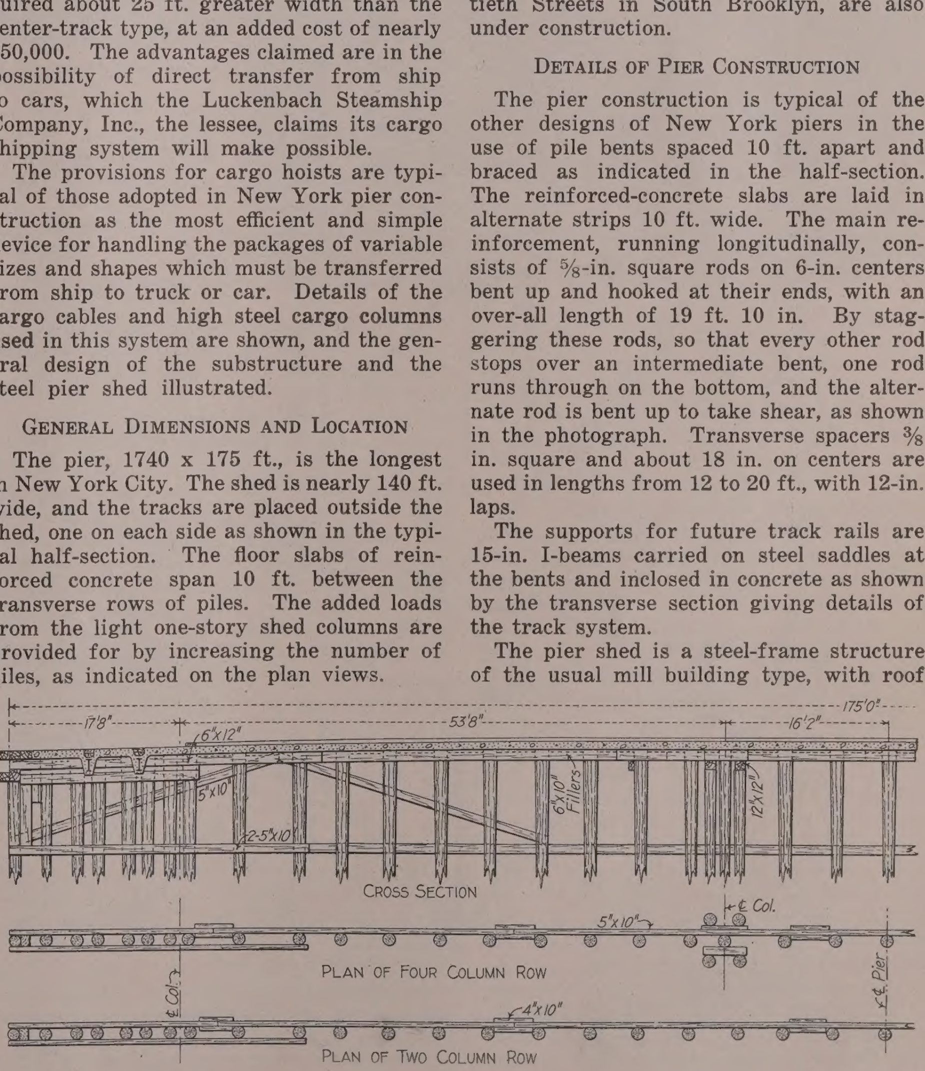
The pier is located at Thirty-fifth Street, South Brooklyn, on Gowanus Bay, and will be connected, ultimately, to the Brooklyn Marginal Railway, which forms part of the tentative, but extensive, plans for increasing the port facilities of New York City. Two other piers, at Twenty-ninth and Thirtieth Streets in South Brooklyn, are also under construction.

DETAILS OF PIER CONSTRUCTION

The pier construction is typical of the other designs of New York piers in the use of pile bents spaced 10 ft. apart and braced as indicated in the half-section. The reinforced-concrete slabs are laid in alternate strips 10 ft. wide. The main reinforcement, running longitudinally, consists of $\frac{5}{8}$-in. square rods on 6-in. centers bent up and hooked at their ends, with an over-all length of 19 ft. 10 in. By staggering these rods, so that every other rod stops over an intermediate bent, one rod runs through on the bottom, and the alternate rod is bent up to take shear, as shown in the photograph. Transverse spacers $\frac{3}{8}$ in. square and about 18 in. on centers are used in lengths from 12 to 20 ft., with 12-in. laps.

The supports for future track rails are 15-in. I-beams carried on steel saddles at the bents and inclosed in concrete as shown by the transverse section giving details of the track system.

The pier shed is a steel-frame structure of the usual mill building type, with roof

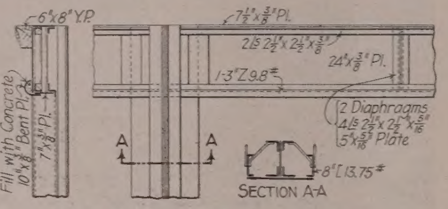


SECTION AND PLANS SHOW TYPICAL CONSTRUCTION OF PILE BENTS—TRACK DETAILS slope of 1 in 5, triangular trusses, and built-up I-section columns. The standard bays between roof trusses are 20 ft. long, and four columns are used in the typical section. The intermediate columns, however, are placed 40 ft. apart and the roof trusses and loads are carried by the 40-ft. longitudinal trusses shown in the drawing. Lift doors are provided in the outside walls of all panels except the first two on the inshore end, as these two bays are to be occupied by offices. Galvanized corrugated steel siding is used throughout.

Twenty-five of the outside row of columns are extended upward to a total height of 50 ft., with a 12 x ⅜-in. cover plate, 28 ft. long, on the outside. A star-angle backstay to the roof truss holds the top of the column transversely as shown in the half-section drawing. The upper ends of these columns are provided with plates for the connection of the 2¼-in. cargo hoist cables and 1½-in. longitudinal stay cables.

Two of the 60-ft. bays in the total length of 1440 ft. between the high end columns are braced by 2¼-in. diagonal cables carried down to roof level, and the end columns are tied by a diagonal 2¼-in. cable anchored into the pier. A special form of door-head girder, shown in the accompanying detailed drawing, not only supports the heavy doors but acts as an eave strut. The 24-in. plate and 8-in. channels of the intermediate columns, also indicated on this drawing, make an effective detail for the door jambs. The bottom door sill is formed by an iron casting 8 in. wide, with vertical ribs 2¼ in. high to act as an asphalt stop.

The assumed live load on the pier is 500 lb. per square foot. For the roof, 70 lb. per square foot live and dead load, with a horizontal wind pressure of 20 lb., were used. The usual allowable stresses, based on 16,000 lb. tension, governed the design of the roof trusses and columns. The cargo cable is designed for three 3000-lb. loads spaced 20 ft. apart, and for the backstays an impact of 100 per cent was added. The assumed angle of application of the loads for maximum backstay stress was 22½ deg., giving a stress of 18,500 lb. in these members. The stresses in the roof truss members from this force were relatively so small that no modification of the sections found by the ordinary analysis for dead, live and wind loads was required.



DETAILS OF DOOR-HEAD GIRDER

The details of cargo-cable connections to columns and adjustable turnbuckles, and the connection to the pier at the end to secure the longitudinal stays, shown on the drawing, are typical of the construction used in New York piers having cargo cables. Experience has shown that no direct access to the cargo cable is necessary. The blocks for use with pier or ship winches are attached to the cable by any ordinary method desired by the steamship company using the pier.

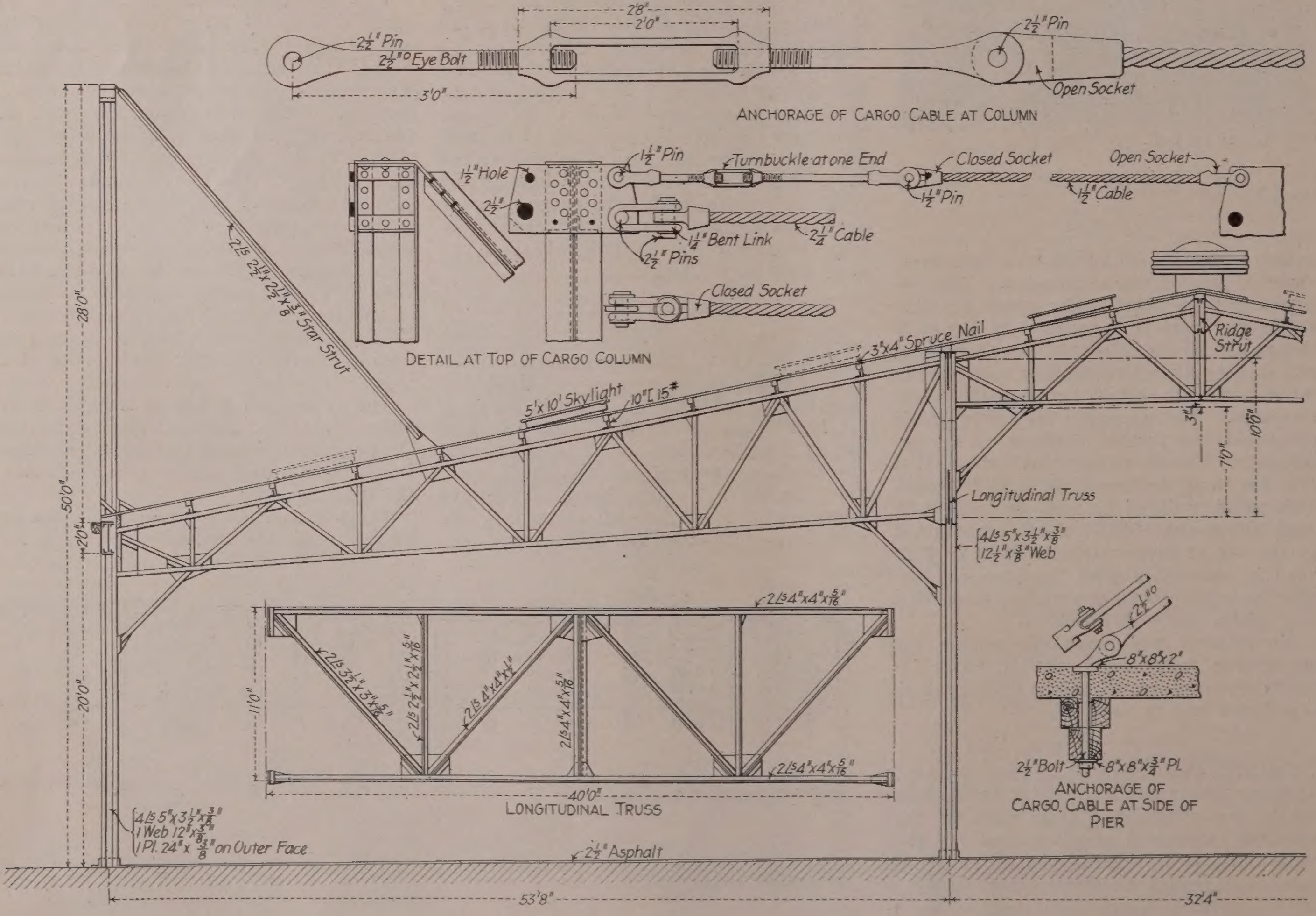
The contractor for the substructure is George B. Spearin, and for the steel shed Post & McCord, of New York City. The design was made under the supervision of R. A. C. Smith, commissioner, Department of Docks and Ferries, of New York City, and R. C. Harrison, deputy commissioner, by C. W. Staniford, chief engineer, and T. F. Keller, assistant engineer.

Concrete Tests Compare Gravel, Limestone and Broken Slag

A SERIES of tests recently reported by the Pittsburgh Testing Laboratory was made for the purpose of comparing the compressive strength of concrete made with either gravel, limestone or broken slag for coarse aggregate. Standard 8 x 16-in. cylinders of 1 : 2 : 4 concrete were made and tested at the end of seven days, twenty-eight days, ninety days and six months. The accompanying table gives the average results of these tests. The number of specimens tested in each group was four, except the last six-months group, where the average for three specimens is given. It is seen that the concrete with slag aggregate is of practically the same strength as the limestone concrete, and both average much higher at all ages than the gravel concrete. The slag was furnished by the Duquesne Slag Products Company of Pittsburgh.

AVERAGE COMPRESSIVE STRENGTH OF STANDARD CYLINDERS IN POUNDS PER SQUARE INCH

Aggregate	Strength at age of			
	7 days	28 days	90 days	6 mos.
Gravel	468	1,001	1,521	1,430
Limestone	792	1,476	2,201	1,904
Slag	788	1,457	2,294	2,288



HALF-SECTION OF PIER SHED AND DETAILS OF CABLE CONNECTIONS

Segregation and Entrained Air Weaken Concrete Dropped from Height Into Forms

Last of Three Articles on Better Concrete — Moving Pictures Show Reasons for Lack of Homogeneity in Finished Mass

By NATHAN C. JOHNSON
Consulting Concrete Engineer, New York

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[*In the two preceding articles of this series there were discussed certain of the basic requirements of concrete and their relation to the limitations imposed on processes of manufacture by economic necessity and by imperfections of mixing apparatus. There were also shown, in relation to common defects of concrete, certain undesirable phases of current practice through analysis of the successive, instant actions of these operation cycles, as caught by the motion-picture camera. In this article further analytical studies are made in regard to the placing of concrete by methods in present vogue and the effect such methods have upon the quality and durability of concrete.*—EDITOR.]

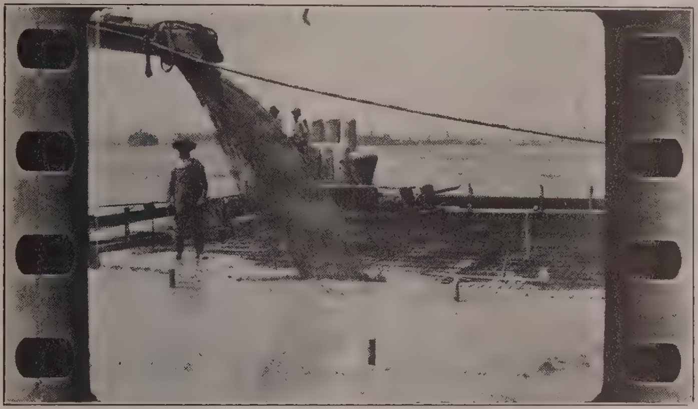


FIG. 12—SPOUTING CONCRETE FROM A HEIGHT TO ILLUSTRATE EFFECT OF DELIVERING INTO TALL FORMS

FROM a time-money point of view, if from no other, there are no operations incident to the manufacture of concrete more important than those of properly placing the mixed materials in the forms. Concrete is very heavy, weighing approximately 2 tons to the cubic yard. It is readily understandable, therefore, that on a job involving from 500 to 200,000 cu. yd., the transporting of this material from mixer to forms and placing it in final position is an economic and engineering problem of no mean order. This phase, of itself, would be sufficient warrant for an intensive study of delivery systems, but when, in addition, it is remembered that these physical operations have a most profound effect on the quality of concrete and the value of structures a detailed examination is made imperative.

FOUR METHODS OF CONVEYING CONCRETE

There are virtually but four usual means of conveying concrete from mixer to forms. Ranked in approximate precedence, according to extent of use, they are:

1. Wheelbarrows or two-wheeled concrete barrows, holding about ¼ cu. yd. each, propelled by man-power.
2. Gravity chutes or spouts, supported and fed from a tower near the mixer.
3. Tilting or bottom-dumping buckets, where the materials can be handled by derricks or cableways.
4. On very massive constructions, side-dumping or bottom-dumping cars of 1 cu. yd. or more capacity running on tracks above or beside the forms.

In the majority of concreting operations either the first or second method is used, or a combination of the two. Considered comparatively, the spouting or gravity system is probably the more favored, especially on work of considerable size. Its economic features are undeniably attractive. To raise concrete vertically in a tower by means of a skip bucket and hoisting engine, distributing by gravity through channels which can be arranged in convenient sections to cover any area inclosed by a radius of from 30 to 200 ft. from the base of the tower, rather than to transfer that same material over specially constructed runways to the several parts of the work, appeals strongly to one's engineering and business sense. Further, the speed of handling by gravity is materially greater; and, conversely, the time cost of placing per cubic yard is much less than in transferring the same quantity of material in hand barrows over more or less expensive and frequently shifted gangways, in cableway buckets or in cars. In addition, better distribution in the forms is secured by a swinging spout end, with prevention of some of those difficulties due to localized deliveries, as explained in last week's article.

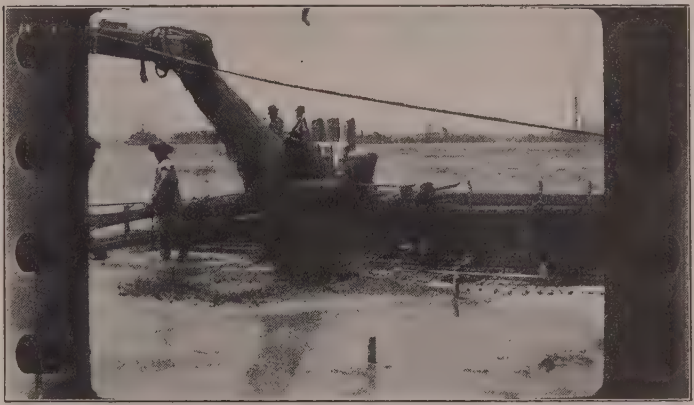


FIG. 13—AIR BUBBLES, AT LEFT SIDE OF STREAM, CAUSED BY SPLASH BOARD AT END OF CHUTE, PASSING INTO THE MASS

Yet in spite of its many good points this spouting system has encouraged many abuses, the effects of which are being appreciated to an increasing extent as the deficiencies of some of the concretes placed by its means are brought to the attention of engineers and contractors through cumulative disintegrations. To consider one feature touched upon in a previous article, it is obvious that to flow readily through chutes concrete must be very smooth and plastic, while, as usually made in 17-sec. mixing where the lubricating quality of flocculent, well-hydrated cement is absent, it is exceedingly sharp and gritty. It is not to be wondered, then, that the lubrication and ease of flow of spouted concretes secured by increased wetness has encouraged the use of large excesses of water, especially on those jobs where the obtainable slope of spouting is very slight, as is frequently the case with a tower of moderate height and tall forms, as in pouring retaining walls.

EXCESS WATER IN SPOUTING

On spouting operations, therefore, inducements three-fold lead to the use of excess water. The first, which applies equally to other means of placing, is ease of mixing. A wet concrete churns far more readily by reason of the lubrication of interparticle water, and presents a more uniform appearance in less time than does a dry, or a semi-wet concrete; this phase of the question has been referred to in the first and second articles of this series. The second inducement is ease and rapidity of flow through the chutes or spouts. The third is the ease of working the plastic mass in the forms, also due to interparticle separation and fluid lubrication. Beyond a question, ease of transportation and manipulation, with low time costs, are highly important, but not sufficiently so to warrant the unmodified continuance of present methods, should it be proved that details attendant upon the practice of these methods are the causes of serious limitations to use and defects in the product.

To determine whether or not spouting methods, as such, are to be held responsible for inferior results, or whether attendant practices are more at fault, a detailed study by means of the motion picture camera is of service. In Fig. 12 is shown the spouting of a very sloppy concrete for use in the reinforced flooring of a pier in New York Harbor. To make clearer the characteristics of the flow and also for special reasons to be pointed out later, the spout was elevated 12 ft. above the forms, the concrete being discharged for a short time from this height. It should be understood, however, that neither on this job nor on other jobs studied by the motion-picture camera was the consistency, distribution, or rate of production of the concrete changed in any way, either for illustrative or for other purposes. In every case the endeavor was rather to photograph unchanged routine, considerable intervals often being allowed to pass in order that normal conditions might be assured, free

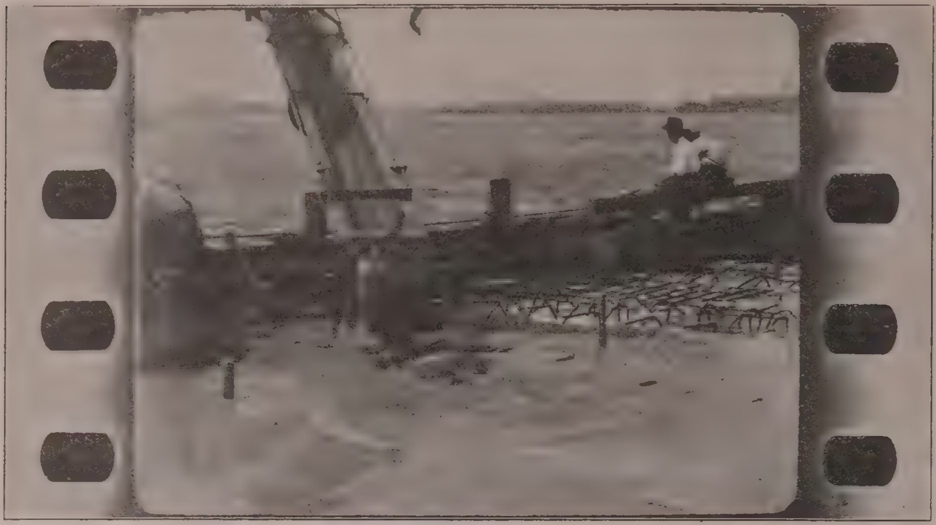


FIG. 14—SLOPPY CONCRETE BOILING AND BUBBLING FROM A SPOUT IN NORMAL POSITION LOWERED ALMOST TO SURFACE OF FORMS

from the embarrassment men sometimes feel when being photographed with attendant breaking of routine.

Aside from this element of unusual height, the operations of Fig. 12 may, therefore, be taken as characteristic of spouting a gravel concrete, the sloppy wetness of which may be judged both by the volume flow from the spout and from the reflections in the water-covered surface of the material already in place. It becomes of general interest and importance, then, to examine the actions as portrayed in this series of instant pictures.

This falling, semi-fluid column of concrete is, of course, a composite of sand, cement, gravel and water. Mixed by a gravity mixer with indeterminate actions, it is safe to assume in this mixture a no more thorough incorporation of materials, and particularly of cement and water, than obtains in concretes made by the 17-sec. machine mixing processes studied in a previous article (Engineering Record, Dec. 4, page 684). This falling column, then, is a more or less homogeneous mixture with water of solid, undissolved particles of cement and of the other solid materials mentioned above, each particle free from attachment to its neighboring particles, save for such viscosity as exists in the water lying between them. Each particle occupies an indefinite and accidental position in the mass, and each is ready to leave that position at any instant in obedience to any new or chance conditions that may arise.

FIG. 15A—CONCRETE BEING DUMPED FROM MIXER TO SKIP WITH DOUBLE FALL

SEGREGATION IN THE FORMS

Disregarding for the present such segregating or separating actions as may take place during transit through the spouting, assume this stream of concrete to be homogeneous at the instant of issuance. Can this same homogeneity hold after delivery in the forms?

Each particle, solid or liquid, in the descending stream possesses a kinetic energy equal to its mass multiplied by the square of its velocity. If such a solid particle, whether of cement, sand or stone, strikes a relatively unyielding surface, it will use up its kinetic energy either in deformation or in rebounding to an uncertain position, for it is essentially unattached to neighbor particles. If it strikes a yielding mass it will penetrate that mass until its energy is dissipated. Remembering the consistency produced by 17-sec. mixing with excess water, without production of a heavy, sustaining grout, segregation in the forms from different mass energies, if from no other cause, is to be expected. Unless some agency should operate to prevent, it is difficult to see how this placing segregation is not later to be aggravated by gravity settlement of the heavier aggregate at the bottom of the slab, where it will be in tension, and concentration of fine sand and the weaker cement, greatly diluted by water, at the top of the slab, to serve as a resistant to compression. The existence of such actions is proved by sectioning concretes placed under these conditions.

FIG. 15B—THE SKIP BEING FILLED WITH CONCRETE—AND AIR

AIR BUBBLES IN FALLING STREAM

Another deduction from this characteristic operation becomes evident on closer study. There is evident in Fig. 13 several very large air bells in the falling stream, passing down into the mass. And, in this same connection, what must be the air-impounding action of that falling fluid mass? An old-time device for gathering and compressing air, known as a "water tromp," is duplicated in action by this falling column of concrete, so that what the mixer left undone in regard to churning air into the mass is probably completed subsequently by this or other pouring actions, whether from barrows, buckets, or spouts of one kind or another.

Although seldom observed because of intervening walls of wood it is evident to any thinker that the conditions attending this open delivery from a height must be duplicated daily in pouring concrete into high forms. The pouring of slabs by an elevated spout, as shown in the pictures, is condemned by all, or to quote the objection of the engineer in charge to the request to elevate the spout: "It will spoil the concrete." Yet identical conditions in closed form work, with a much higher drop, excite no comment. In operations of this general character it is doubtful justice to place responsibility for inferior work on materials alone.

FIG. 15C—RUSH DOWN SPOUT AFTER PASSING DEFLECTOR PLATES FOR RE-ESTABLISHING MIX

There are, however, other features typical of spouting concretes which are illustrated in the photographs of Fig. 14. In these photographs, taken on the same job, the spout is in normal working position—lowered almost to the surface of the forms. By reason of its fluidity and the slope of the spout the concrete is delivered with considerable velocity. In this case also, as in the falling column of concrete, each of the component, unattached particles possesses kinetic energy proportional to its mass; this energy must be dissipated before the particle comes to rest. In addition, the descending concrete stream carries air in quantity into the plastic concrete previously deposited, causing it to bubble and boil vigorously, as may be seen in the photographs. It is no wonder that concretes so placed carry a bulk of entrained air of sometimes 20 per cent of their bulk.

It is recognized that certain of these more or less undesirable actions seem at present to be exceedingly difficult of overcoming. A certain amount of air is certain to be occluded in a plastic mass, and variation in distribution and proportions of materials is an evil attendant upon rough, volume measurements. In spite of these shortcomings, much trouble could be avoided were the primary mixing sufficient and effective, so that a heavy-bodied, viscous grout might be had at the outset, and were every effort made to prevent those unclosed pourings and separatings and splashings that now form so conspicuous a part of most field practice. A gentler, more careful and more thorough handling of concrete is both advisable and necessary and is not inconsistent with speed of construction or the realizing of profits.

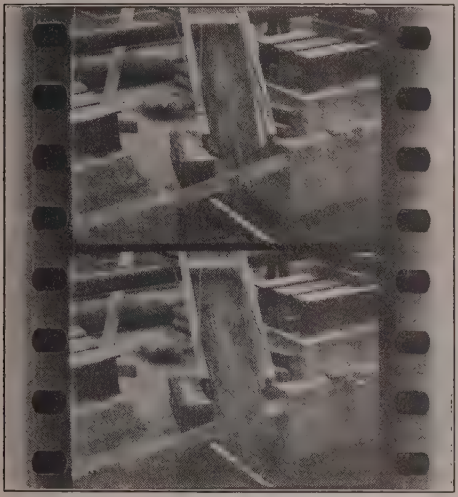


FIG. 15D—EXIT, WITH LIGHTEST AND WETTEST MATERIALS IN EXCESS

MOVING PICTURE EVIDENCE

As illustrating customary procedure in the handling of an average concrete, consider the series of operations on a spouted job, incident to placing the mixed materials in the forms, as shown in Figs. 15a to 15f.

Starting with its discharge from the mixer, the concrete is seen (Fig. 15a) falling into a skip at the tower base in an aerating double cascade, occasioned by striking an auxiliary chute placed to prevent wastage. In Fig. 15b is shown the skip bucket from above, full of concrete—and air—ready to be hoisted into the tower. Then the skip bucket, high in the tower, dumps with another cascading into the receiving hopper at the chute ahead, whence the concrete passes into and through the chutes. In Fig. 15c is caught the first grand rush of finer and softer materials through the last section of chute, catching up with the heavier aggregate separated out and left from the last batch. Fig. 15d is the exit of these materials from the chute end in so fast-flowing a stream that the camera could catch only a blur; while in Fig. 15e is a similar rush, spattering and splashing into the concrete already in the forms, with a crater, or envelope of air visible about the descending materials. And in Fig. 15f are shown the heavier, segregated materials, separated from the sand and cement either in the receiving hopper or in the chutes, dribbling slowly along, although the chute is at an unusually steep pitch. Do these practices produce the best concrete obtainable, or even the best that may be produced at the present price paid for such work? Few, if any of the many able engineers directing concrete work would acknowledge this to be the case.

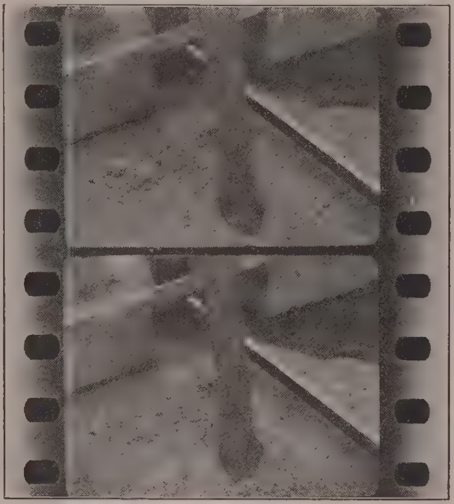


FIG. 15E—SPLASH INTO FORMS, WITH SEGREGATION AND IMPOUNDING OF AIR

The foregoing series of photographs were made on a job using a medium wet concrete. The concreting was also well ahead of the other work so that quantity output was not a prime essential, and, furthermore, the inclination of the spouting was steep, so that slow delivery and a relatively dry mix were permissible. Yet, even in this concrete, segregation is evident; and the dribbling of the heavier materials through the chutes which brings about part of the demand for wetter concrete is illustrated with clearness.

The tendency toward the use of excess water is thus seen to be natural, as meeting most easily an economic demand for low placing cost per yard, brought about primarily by keen, competitive bidding. But if it is granted that such consistency and violent handlings are productive of inferior results, is not this lower unit cost false economy? And are over-wet concretes and kinetic or gravity segregations inseparable from spouting operations? The determining factor in rapid, effective spouting is lubricated flow. It would seem either that a harmless lubricant might be added, or else that through a rational development of mechanical mixing processes, this lubricant might be produced from the inherently capable cement and water, so that the desirable features of spouting might be retained with the disadvantages eliminated. More experiment is needed to prove conclusively the commercial feasibility of these improvements, but enough is already known to give encouragement for their early realization.

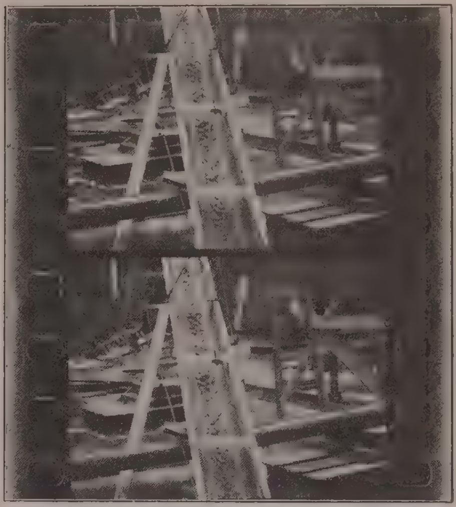


FIG. 15F—SLOW DRIBBLE OF HEAVY MATERIALS SEPARATED FROM CEMENT IN SPOUT

SLIDING VS. ROLLING IN CHUTES

Not a little controversy has been waged over the method of transit of materials through the chutes themselves, insistence being placed by many upon a sliding, as opposed to a rolling of the aggregates. Viewed in the light of motion picture studies, with consideration given to the excess wetness and the inevitable gravity segregation common not only to spouting, but

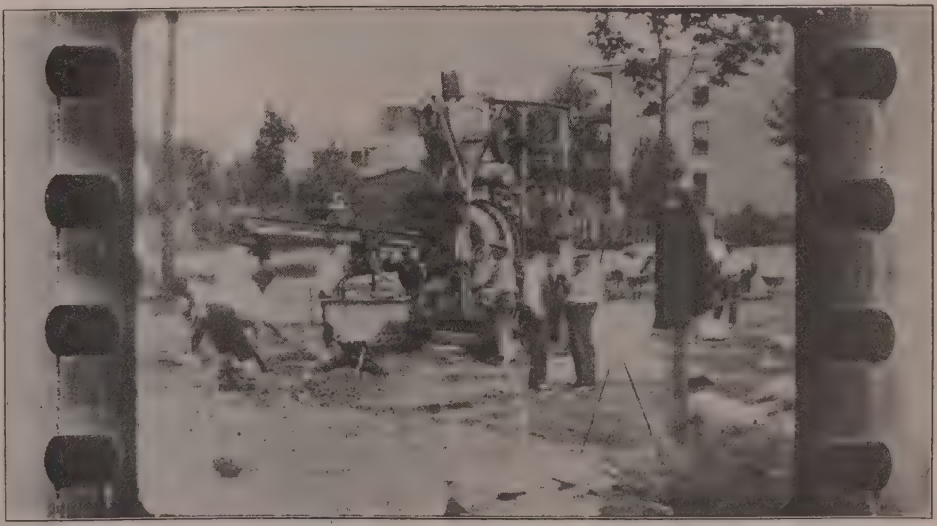


FIG. 16—SPLASHING DISCHARGE OF CONCRETE FROM BOTTOM-DUMPING BUCKET USED TO DEPOSIT FOUNDATION COURSE FOR ROAD

to other placing operations as well, does not such a debate savor of that other reputed to have once waged so hotly in regard to which end of an egg, the big end or the little end, was the proper end to open? Compared to excess water, or to a splashing delivery into a skip bucket, or to segregation in the chutes, with attempted recombination by splash boards at the section joints, or to pounding, splashing delivery from a height, or to kinetic and gravity segregation in the forms, is not this question of very minor importance? And compared to the importance of that initial operation of mixing, the basic function of which is a proper production of the gluing, or cementing substance designed to hold the inert, incoherent materials together, are not such questions insignificant? If proper mixing and, partly through the enablement of such proper mixing, proper consistency were once secured, there would be little need to worry about rolling, or sliding, or splashing, or segregation, for the mass would be free-moving, sufficiently viscous not to separate, self-lubricated and probably unaerated as compared with present concretes.

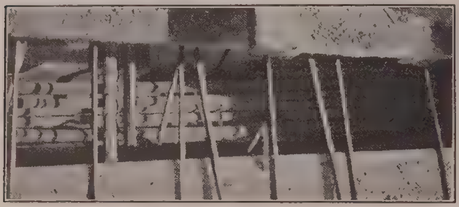


FIG. 17—STEEL REINFORCEMENT IS OFTEN TOO CROWDED FOR BOND WITH CONCRETE

Bottom-Dumping Buckets

Space does not permit of a close analysis of the delivery of concrete from bottom-dumping buckets, or from side-dumping, or bottom-dumping cars. In general features such operations closely resemble the dumping from wheelbarrows, save that in bottom dumping the stone is first and the more fluid portions last delivered, with perhaps something of advantage on this account, because of gravity penetration of the lighter, fluid materials into and between the heavier, solid portions below them.

An illustration of delivery of this character is given in Fig. 16, showing a paving mixer with boom bucket at the instant of dumping. Here again may be seen the splashing discharge from mixer to bucket, probably segregation in the bucket and dumping in a heap, with drainage of the lighter and more fluid materials. But perhaps of more serious consequence to the roadway than the influence of these factors of handling is the regrettable fact that few precautions are taken, in far too many cases, to secure a properly drained and bedded foundation for the concrete top. The necessity for committees to determine and prescribe the quantity of steel reinforcement to be put in concrete roads, which should carry no beam stresses, to prevent the concrete from cracking is no compliment to a material which should be sufficient of itself and most excellent for the purpose.

Bond Between Steel and Concrete

But another phase of the manufacture of concrete must be considered, in addition to those dealing only with the composite material itself. A relatively small portion of concrete work is without steel reinforcement, this reinforcement being designed to act, when surrounded by concrete, as an integral part of the mass and to bear virtually all tensile stress. But in order that it may so act, close contact must be had between concrete, mortar and steel. Further, the steel must occupy a definite, predeterminated position in the mass, or else its proper functioning is prevented, possibly to the extent of uselessness.

The use of sloppy-wet concretes to bring about close contact between cement and steel is common, but there seems to be no more cause of such a concrete to bind closely to steel after loss of water than there is for it to closely contact with its sand and stone, which it is known not to do. And if to such qualities of the concrete are added misplacement of the reinforcing steel or, as is shown in Fig. 17, the crowding together of many large steel bars in a narrow beam with scarcely a knife-blade crack between, virtually cutting off the beam at the steel and preventing any proper surrounding by the cement, a result below standard is inevitable.

What the Future Holds

The more carefully concrete is studied the more does the conviction grow that its qualities to-day are far below those which it should possess, and that its present field of usefulness will be extended many-fold in the not distant future. Much yet remains to be accomplished, but day by day and little by little the work is being done and the difficulties removed. Whether the ultimate outcome will be an economic readjustment, permitting a higher rate of payment for a superior product, or whether it will be mechanical refinements of apparatus and methods, producing these desirable results at the same price, or whether it will be a compromise of the two, does not yet permit of accurate determination. Judging, however, from the history of all industry and from the known crudities of today's manufacture the highest development will be reached through mechanical refinements, with an even greater economy of human energy and a corresponding contribution to the safety of the public.

[*This concludes Mr. Johnson's series on common abuses in mixing and placing concrete. He has stated the facts. It remains for engineers, contractors, and manufacturers of equipment to evolve improvements in current practice. If this occurs the series will have started a real constructive movement.*—Editor.]

How Louisville & Nashville Repaired Storm Damage Along Gulf of Mexico

Emergency Work Following Hurricane of Sept. 29 Included Restoration of Embankments, Pile Trestles and Short-Span Bridges

Damage done by the storm of Sept. 29 to the main line of the Louisville & Nashville Railroad between Pascagoula, Miss., and New Orleans, where the road skirts the Gulf of Mexico, was so extensive as to put the section of the road between Henderson Point, Miss., and Chef Menteur, La., completely out of commission. From the first warning by the U. S. Weather Bureau of the impending advent of a tropical hurricane, however, the railroad bent every effort to preparing for trouble and repairing the damage as rapidly as possible. Consequently, although hundreds of feet of pile trestles and short-span steel bridges were swept away and miles of embankment were wholly or partly washed out, the section worst affected being 35 miles long, and although the absence of other rail lines reaching this section made it virtually necessary for the repair forces to work in from the ends, the whole line was in shape Oct. 24 for the very slow passage of trains. Revenue freight trains resumed movement over the whole division on Oct. 27, and passenger trains on Oct. 28.

Preparations Made in Advance

Previous to the storm the railroad's general offices at Louisville received advice through the U. S. Weather Bureau that a tropical hurricane would probably strike the coast between Mobile and New Orleans. Telegraphic orders were issued at once to the superintendents of other divisions than the New Orleans division to have men in readiness to move in boarding cars to the seat of the trouble, and to accumulate such materials for making repairs as was in stock. Under these instructions large quantities of cross ties and a very considerable amount of heavy timber were loaded for blocking, and both trackmen and bridgemen were held in readiness to move. Immediately after the storm the division organization made such repairs as were prac-

ROADBED NEARLY OBLITERATED AT SITE OF RIGOLETS STATION—NOTE SCHOONER ACROSS RIGHT-OF-WAY IN DISTANCE ticable, but on account of the magnitude of the damage they could not accomplish much. The wisdom of calling in advance on the other divisions for help was amply demonstrated, both the men and the material being put to good use.

Working in from the east end after the storm, the first serious trouble was encountered at Bay St. Louis, Miss., which was reached by the main repair forces Oct. 1, about 30 hr. after the storm. Prior to that the division forces had repaired minor damages to embankment at Pascagoula Bay and at Biloxi Bay.

DAMAGED TRACK AT RIGOLETS, AND RESTORED TRACK AT DUNBAR—IN RIGHT-HAND VIEW OLD TRACK IS IN CANAL

RIGHTING A DISLOCATED DRAWBRIDGE

Bay St. Louis is crossed by a creosoted pile trestle 9837 ft. long, in which there is a steel through truss drawbridge 192 ft. long. Parts of the trestle deck were carried away, although little damage was done to the bents. The anchor bolts attaching the drawbridge to the center pier were sheared off, and the whole bridge was shifted laterally about 6 ft. Only the lodging of the balance wheels on the extreme edge of the concrete pier prevented the draw from going into the bay. As the draw stood after the storm, the south truss was about 5 ft. higher than the north, the whole span having been tilted over.

A large barge was placed under each arm of the draw. In order to do this it was necessary to fill them partly with water, and after they were placed in position to pump the water out, and then wait for the rising tide to assist in taking the dead weight of the draw. The draw span, however, was lifted to a level position and shoved over laterally to its proper center mainly by the use of jacks. No damage was done to the trusses, and very little to the floor, but a considerable amount of damage was done to the turning mechanism and to the balance wheels and wedges which support the draw when in position for trains.

Night and day forces of bridgemen worked on the trestle and the draw, and this work was carried on continuously, notwithstanding the very heavy rains which prevailed during the earlier part of the work. Sufficient repairs were made to permit the passage of trains over the structure at 1 p. m. Oct. 4.

Beyond Bay St. Louis the roadbed was very badly cut at intervals, especially beyond Pearl River, 16 miles from Bay St. Louis. In many places the embankment was cut out to the tide level, while at one point both main track and side track were swept from the embankment and turned over into the canal alongside the tracks.

After getting over Bay St. Louis both bridgemen and trackmen devoted themselves to blocking up the track and putting it in condition to pass work trains, and on Oct. 14, Rigolets Bridge was reached.

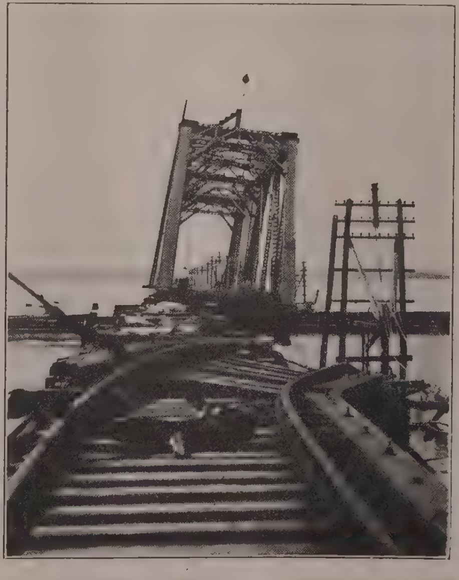
RIGOLETS BRIDGE REPAIRED IN TEN DAYS

Rigolets Bridge, which is in Louisiana, crosses one of the outlets of Lake Pontchartrain. The bridge is 2508 ft. long, consisting of 2272 ft. of short steel girder spans and a 236-ft. draw span together with a pile approach trestle at the north end. Thirteen 55-ft. deck girder spans and two 60-ft. through girder spans were carried away by the storm, with their supporting piers. In addition, one 55-ft. deck girder span at the other end of the bridge was so badly damaged by collision with a steel coal barge that it had to be removed, and 944 lin. ft. of the approach trestle were destroyed.

Three floating pile drivers, which were brought by water, and two heavy steel track pile drivers were used in driving a heavy trestle across the breaks in this bridge. A large stock of very long piles had been accumulated before the forces could reach the structure, as well as a quantity of stringers, cross ties and bracing. A large outfit of tugs, barges and motor boats was provided for handling material and men. At one time there were on the job nine barges, each having carrying capacity of 150,000 ft. b.m. of lumber, four tugs and three gasoline motor boats.

ROADBED RESTORED UNDER DIFFICULTIES

The track equipment still had to work from the east end only, on account of the large amount of damage done west of Rigolets and the difficulties attending the repair work. At Chef Menteur, the other outlet of Lake Pontchartrain, 11 miles from Rigolets and about 20 miles from New Orleans, 330 lin. ft. of girder spans with their supporting piers were destroyed. The intervening roadbed was damaged more than that at any other point. Here the road lies through a salt marsh, the general level of which is 1 or 2 ft. above mean tide, the tidal range being only about 1 ft. The railroad embankment itself is only about 4½ ft. above the level of the marsh.



BAY ST. LOUIS DRAW SPAN TILTED OVER EDGE OF PIER

Work train equipment was sent to Chef Menteur from New Orleans via other lines of railroad, and while a temporary trestle was being thrown across the break, forces were put to work restoring the roadbed between the two bridges. The conditions were very unfavorable, however, to rapid work. There was but a meager population in the salt marsh, and most of the houses were destroyed by the storm. Consequently prior to the opening up of the trestle across Chef Menteur it was necessary to transport the track forces from New Orleans and return each day by boat. As soon as Chef Menteur bridge was passed a long string of boarding cars for the men, with ample supply of water in tank cars for the locomotive engines, followed behind the gangs as fast as they could put the track in rough shape for work trains. It was on the morning of Oct. 24, however, ten days after the arrival of the forces from the east, that a third track pile driver reached Rigolets Bridge from the New Orleans end, and at 6.30 p. m. that evening trains were passed over the structure.

In order to put the track in shape for regular operation in the shortest possible time, large quantities of blast furnace slag were hauled by train from the vicinity of Birmingham, Ala., a distance of about 300 miles. Up to Dec. 1 about 80,000 cu. yd. of this slag had been used for surfacing the track.

The maximum force engaged on this repair work was probably nearly 1000 men. It was carried out under the direction of W. H. Courtenay, chief engineer, and Thomas Maney, general roadmaster.

EXPANDED METAL POLES are used on the right-of-way of the Elgin, Joliet & Eastern Railway near East Chicago, Ind., for carrying the 11,000-volt transmission line of the Northern Indiana Gas & Electric Company, and also telephone and telegraph lines. About 1 mile of 35-ft. poles have been installed. Steel angles are used as cross arms, and the poles are set in the ground with portable concrete blocks, making concrete mixing at the site unnecessary.

Engineers' Technical File Should Be Small, Up-to-Date and Easily Kept

Elaborate Subject System Undesirable—A Restricted Loose-Leaf Notebook and a Vertical File Should Supplement Relatively Few Bound Volumes

By LOUISE B. KRAUSE
Librarian, H. M. Byllesby & Company, Chicago

EVERY ENGINEER has important printed or manuscript material in his possession which he wishes to preserve for future reference in the practice of his profession. The problem, therefore, which confronts him is to ascertain what is the best method for filing his material so that he can know not only what information he has on a subject, but also how it is filed, so that he can put his hand upon it immediately, without loss of time. The writer believes that the best solution lies in a bookcase of a few bound volumes covering the engineer's specialty, a loose-leaf notebook and a vertical file for matter not adaptable to the notebook. Both the loose-leaf matter and that in the vertical file should be inserted and numbered consecutively as obtained, rather than by an elaborate subject system. It should also be restricted, and obsolete data should be weeded out from time to time.

OBJECTIONS TO SUBJECT FILING

Readers of technical periodicals for the past few years have seen a number of articles written by engineers on the methods which they have individually worked out for filing their technical information. The majority of these articles recommend the expansion of the Dewey decimal classification to suit the need of the particular branch of engineering in which each engineer is most interested. In brief they recommend making a subject classification covering all the details of a particular subject, arranged in logical order, or to quote from an article recently published in a technical periodical, "An original classification drawn up to conform with the individual's need and viewpoint will prove the most satisfactory in the end. In such a classification the headings should be arranged in a sequence logical enough so that the position of every heading can be readily recalled."

Taking it for granted that the Dewey decimal classification does not cover engineering subjects with as great detail as is desired, there are, however, serious objections to the recommendations which advocate the drawing up of original classifications by engineers to suit their individual needs. The objections briefly stated are as follows:

1. The average engineer has not the time to work out an original classification, and even if he did have time it could be spent to greater advantage in study and reading along the lines of his profession than in devoting the many hours which would be necessary to working out an original scheme for filing.

2. The average engineer would not be successful in working out an original classification unless he had some instruction in the principles underlying the subject; for classification making is one of the most difficult branches of library science.

3. Although subject classification according to the decimal system is, without doubt, the best method yet devised for filing information, there are simpler methods of filing technical material which require no time or study to put into operation and which are quite satisfactory in keeping up an individual file.

Methods of Filing

Technical material exists in practically three forms (books and periodicals, manuscript data and clippings) and must be filed according to the form of the material in one of the three following ways:

BOOKCASE

1. A bookcase. In his bookcase, which need not be a large one, the engineer will keep his few worth-while books. They will not be many, because the best works on any particular branch of engineering are in reality few. This fact is also true of technical periodicals, and the engineer specializing in some specific branch of engineering will find that two or three periodicals are all that he needs in addition to the publications of the particular national engineering association which represents his line of work.

The arguments in favor of an engineer binding instead of clipping the few journals of particular interest to him have been stated by the writer in the Engineering Record, April 27, 1914, page 479. In addition to these reasons it may be stated also that one of the chief arguments against binding periodicals, namely, that they take up too much room, is negligible, when one considers that three feet of shelving will hold twelve volumes of a periodical the size of the Engineering Record.

The practice of clipping everything has almost become a fad since the widespread adoption of the vertical filing system. But the vertical file, valuable as it is, should never supplant for the engineer the time honored bookcase containing a small but up-to-date collection of volumes which are most helpful to him and the possession of which is one of the marks which designate him as a worthy member of his profession.

LOOSE-LEAF NOTEBOOK

2. A loose-leaf notebook. An engineer's notebook should contain original notes collected in his practice, also manuscript data collected from various sources. As far as possible all especially useful data should be put in this notebook so that they can be readily carried by the engineer wherever he goes. It is worth while for this reason to have copies made of working data of particular value, and put into the notebook, even though they may be found elsewhere. The best notebook for this purpose is a ring binder, size 9 x 11 in., with a flexible leather cover. All notes should be put on standard-size sheets and numbered consecutively when they are inserted, like the pages of a book. The notebook should contain index sheets, a sheet for each letter of the alphabet, and on these sheets should be recorded the subjects of the various data put into the book with the page number showing where it can be found.

Care should be exercised in making this subject index to be consistent and uniform in the use of subject names, and also to provide cross references where necessary. Each piece of data should be indexed under its most specific subject heading and not under a broad term which includes several definite divisions of a general subject. It should be indexed not under one subject only, but also under any other subjects on which it gives useful information. Cross references should be made from synonymous terms not used to the term under which the entry is made.

The objection to consecutive numbering in filing data is, of course, that it is more logical to have all data on a subject stand together, but when one considers that often the same piece of data may bear equally on two subjects, and unless it were duplicated can be filed only in one place, one finds the objection to consecutive numbering for a personal file to a large extent theoretical rather than practical. It is certainly much easier for a busy man not trained in the intricacies of subject classification to use a consecutive numbering system with a subject index, than to endeavor to work out an individual subject classification to cover all of his material.

VERTICAL FILE

3. A vertical file. In the vertical file is placed printed or manuscript information which is excluded by reason of its form from a bookcase or a notebook. Each piece of information that is put into the vertical file is numbered consecutively beginning with 1, on the same plan as the arrangement of the notebook, and the reason for so doing is the same. A subject card index is made on the same plan as the subject index to the notebook. As a vertical file and its contents cannot be carried about like a notebook, an index on cards is preferable to an index on sheets, which is used for the notebook data.

It is advantageous to include in the card index to the vertical file any subject references to periodical articles of personal value to be found in the volumes of periodicals. This is particularly important because with few exceptions the individual volumes of technical periodicals are badly indexed and are poor helps in locating a special article in a hurry. It may be profitably noted in this connection that the *Industrial Arts Index*, a cumulative bi-monthly, published by H. W. Wilson & Company, White Plains, N. Y., is an excellent subject index to the more important technical periodicals, and is to a large extent solving the problem of how to use effectively bound volumes of periodicals whose individual indexes are poor.

Both the notebook and the vertical-file plan for filing and indexing as outlined in this article have been used for a number of years by an engineer of high standing and have been found to amply take care of his personal material. The scheme presents a simple and satisfactory solution of the filing problem for a busy man with a minimum of time to devote to keeping his collected data in working order.

RESTRICTION OF MATERIAL

Another aspect of the general topic under discussion may be noted as follows: It is important to keep personal files down to as small a compass as possible, and the engineer will be wise if he adopts the plan of systematically discarding data his experience has outgrown, or which has been superseded by other material. If he is employed by a large company, maintaining a well organized filing department and a library, his personal file can be kept quite small because of the organized service at his disposal. If he is building up a business of his own, and his personal file is beginning to partake of the interests of an organization, he will need to put the material into the hands of some one capable of administering it on a larger plan than is required for purely personal needs. If the latter condition be the case and there be definite need for an expansion of the Dewey decimal classification at certain points, the following list of existing extensions to the Dewey decimal classification may be of interest:

EXTENSIONS OF THE DECIMAL CLASSIFICATION

University of Illinois Engineering Experiment Station Bulletin 9, Revised edition, 1912.
"Extension of the Dewey Decimal System of Classification Applied to the Engineering Industries," by L. B. Breckenridge and G. A. Goodenough.
"Extension of Dewey Decimal System of Classification to Cover Municipal Engineering," by R. De L. French, in *Canadian Engineer*, Nov. 12, 1914.
"Extension of the Dewey Decimal System of Classification to the Gas Industry," by D. S. Knauss, American Gas Institute, October, 1914.
"Extension of the Dewey System of Classification Applied to Metallurgy, Metallography and Assaying," by R. M. Keeny, Colorado School of Mines, quarterly, Golden, Col., April, 1911.

In conclusion it might be well to state that this article is written, not to minimize the importance of subject classification, but to point out a simple and practical way of filing by which the busy man can avoid the serious difficulties which subject classification is bound to entail, especially when undertaken by the uninitiated.

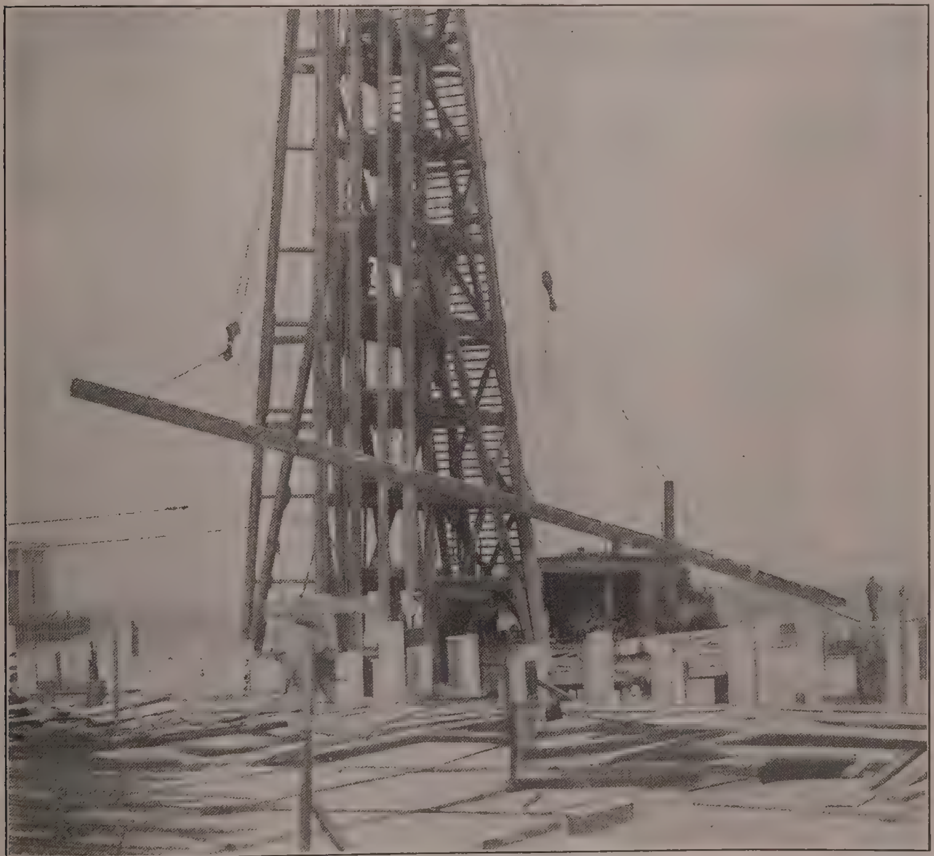
Driving 106-Foot Concrete Piles in San Francisco Piers

PIER CONSTRUCTION in San Francisco Bay has called for concrete piles of unusual length because a considerable depth of soft mud and ooze overlies the solid bottom in many places where all-concrete structures have been built. The engineering department of the State Harbor Commission has designed and built longer and longer piles as the work has progressed, until on the outer end of Pier 35 it was deemed advisable to use piles up to 106 ft. in length in the last few bents. The accompanying photograph shows one of the 106-ft. piles being raised to the driver.

The longest piles were 20 in. square at the butt with wedge-shaped tips 10 x 20 in. in cross-section. The reinforcing consisted of eight 1-in. bars with continuous hooping of No. 3 wire wound on 3-in. centers, except for 4 ft. at either end, where the winding was on 2-in. centers. The harbor commission's standard concrete mix was used, consisting of one part of cement and five parts of aggregate proportioned for maximum density. Thus far only two piles have been lost, it is reported, on account of breakage in driving.

The piles are cast at a point from which they could be conveniently skidded upon barges, which were towed to the driver, so that there was no unnecessary handling between casting yard and pier. In lifting piles more than 80 ft. in length it is the custom to sling each unit from lines attached at four points, as shown in the accompanying illustration. A three-drum hoisting engine is used, the third drum being used to operate the steam hammer. The concrete structure, or the pier proper, is protected by a fender line of creosoted piles with triple car-spring buffers between fender-line stringers and concrete beam. The creosoted piles are protected by green timber sheathing.

The piles have been designed under the direction of Jerome Newman, chief engineer, State Harbor Commission.



HANDLING A 106-FOOT CONCRETE PILE ON SAN FRANCISCO PIER WORK—NOTE METHOD OF SWINGING, WITH TWO FALLS AT FOUR POINTS OF ATTACHMENT

Supreme Court Upholds Missouri Drainage-District Law

Contention Is Dismissed That Tax Laid Level and Not According to Benefits Confiscates Property

ON Nov. 29, 1915, the U. S. Supreme Court handed down a decision affirming the constitutionality of the law under which drainage districts are formed in Missouri. The case was that of certain landowners in the Little River Drainage District. The contention was that the law was unconstitutional because a tax of 25 cents per acre for preliminary expenses was laid without relation to benefits, but as a level tax, and thus, since the plaintiffs' lands would be less benefited than others, that the procedure was in the nature of taking property without due process of law and in violation of the Fourteenth Amendment of the Federal Constitution. The law had already been sustained by the Missouri courts.

On the main point in question, the opinion, delivered by Justice Hughes, is as follows:

"The ultimate contention is that the plaintiffs in error cannot be subjected to this preliminary tax of 25 cents an acre because their lands, as they insist, will not be benefited by the plan of drainage. In authorizing the tax, it is said, the Legislature has departed from the principle of benefits, and the tax is asserted to be *pro tanto* an uncompensated taking of their property for public use. But the power of taxation should not be confused with the power of eminent domain. Each is governed by its own principles. A tax is an enforced contribution for the payment of public expenses. It is laid by some rule of apportionment according to which the persons or property taxed share the public burden, and whether taxation operates upon all within the state, or upon those of a given class or locality, its essential nature is the same. The power of segregation for taxing purposes has every-day illustration in the experiences of local communities, the members of which, by reason of their membership, or the owners of property within the bounds of the political subdivision, are compelled to bear the burdens both of the successes and of the failures of local administration. When local improvements may be deemed to result in special benefits, a further classification may be made and special assessments imposed accordingly, but even in such case there is no requirement of the Federal Constitution that for every payment there must be an equal benefit. The state in its discretion may lay such assessments in proportion to position, frontage, area, market value, or to benefits estimated by commissioners. And, as we have said, unless the exaction is a flagrant abuse, and by reason of its arbitrary character is mere confiscation of particular property, it cannot be maintained that the state has exceeded its taxing power. We find no such arbitrary action here. It was not necessary to base the preliminary tax upon special benefits accruing from a completed plan. . . . Whether the expense of ascertaining the best method of reclamation should subsequently be reimbursed when final assessments were laid according to benefits ascertained to result from the execution of the final plan presents a question of policy and not of power."

Elastic Curves and Influence Lines Simplify Analysis of Beams

Graphical Diagrams for Deflections and Reactions of Cantilever, Simple, Fixed-Ended and Continuous Beams with Variable Moments of Inertia

By J. P. J. WILLIAMS
Associate Editor, Engineering Record

THE usual analysis for the statically indeterminate reactions of fixed-ended and continuous beams is based upon the assumption that the moment of inertia is constant throughout the length of the beams. For ordinary draw spans such an assumption varies widely from actual conditions; in fact, all well-designed continuous beams have widely varying moments of inertia. The graphical methods to be developed herewith make possible a fairly rapid and accurate analysis, which not only includes the effects of variable moment of inertia, but gives a clear idea of the variation in reactions, shears and bending moments by the use of easily constructed influence lines. In addition, formulas for the reactions produced by unequal settlement of supports will be given.

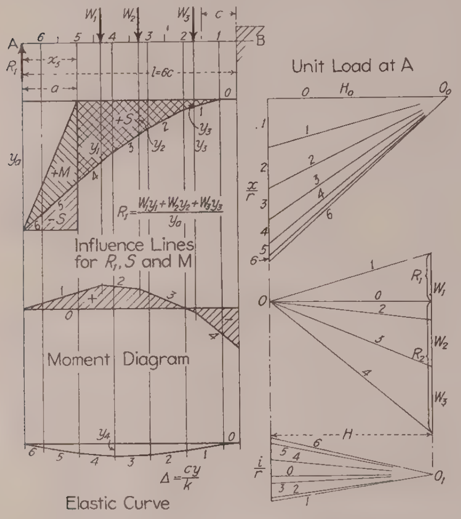


FIG. 1—DEFLECTION OF CANTILEVER BEAM

For all cases of beams in buildings in which plastered ceilings are used and the limit of allowable deflection specified, the actual deflections of beams of various types are of importance in design. Formulas for deflection in common use are based upon the assumption of constant moment of inertia. A more exact analysis for deflection, based upon the simple construction of an elastic curve, will be developed and applications to several cases considered in detail. The methods are applicable either to steel or to reinforced-concrete beams with variable moment of inertia, and will be explained in connection with the following examples: Cantilever beams, simple beams, beams fixed at one end, beams fixed at both ends, continuous beams of two spans and continuous beams of three spans. While the details of the treatment are original, the fundamental methods are those already discussed by D. B. Steinman and C. S. Whitney in the articles in the Engineering Record in the issues of Aug. 28, page 258, Sept. 11, page 324, and Oct. 16, page 486.

FUNDAMENTAL RELATIONS AND EQUATIONS

The familiar force polygons, moment diagrams, or funicular polygons, and influence lines are the graphical methods used. The fundamental basis of the theoretical relations is the following equation for vertical deflection $\triangle$, from the tangent to the neutral curve, as given in standard texts:

$$\triangle = \int \frac{Mx\,dx}{EI}$$

Either of two procedures can be adopted to simplify this computation and transform it for use as a graphical summation when the moment of inertia is variable. The length of beam, l, can be divided into such variable short lengths, dx, as will make the value of dx/EI constant so that it can be removed from the integral and the latter changed to a finite summation. Let $dx/EI = C$, then

$$\triangle = C\,\Sigma\,Mx$$

Or, a value I_1 for the moment of inertia of one section can be divided into the other values of I to obtain the ratio r equals I/I_1 as a variable, and the short lengths, dx, made constant, c, and selected according to the accuracy desired and their relation to the sections of constant moment of inertia. The resulting form is

$$\triangle = \frac{c}{EI_1}\sum \frac{M}{r}x$$

Owing to the greater control and flexibility of the second method, its simplicity and accuracy in application, it has been adopted in the analysis which follows. It is seen to differ in the summation term only in the fact that M/r replaces M as the multiplier of the variable, x.

To obtain the deflection, $\triangle$, by graphical construction, if i is the intercept of the moment diagram drawn with a pole distance, H, then $M = Hi$, Fig. 1. Substituting this in the equation for deflection, there results:

$$\triangle = \frac{cH}{EI_1}\sum \frac{i}{r}x$$

By then plotting the values of i/r as a load line, a second polygon with pole O_1 and pole distance H can be constructed to give the summation graphically. Then

$$\sum \frac{i}{r}x = H_1 y$$

can be substituted, and there is obtained

$$\triangle = \frac{cHH_1y}{EI_1}$$

Let $k = EI_1/HH_1$. Then $\triangle = cy/k$.

In general measure the vertical intercepts to the same scale as the load line, and pole distance to the space or length scale of the diagram. To get the deflection in inches, all units should be inches, or if H, H_1 and c are in feet, $\triangle = 1728cy/k$. If convenient, H_1 can be made equal to H, then $k = EI_1/H^2$.

ADVANTAGES OF GRAPHICAL CONSTRUCTION

The great advantage of graphical construction is in the fact that relative deflections of different points are thus obtained and the vertical deflections of the points of the beam with respect to each other are indicated, when the deflections with respect to one tangent, found by the construction, are known. Hence when the relative deflections of certain points are known, the position of the base line of reference for the elastic curve is easily determined. The exact values of the deflection can then be computed by the above equations from the intercepts, y, of the elastic curve.

The ease with which influence lines for reactions, shears and bending moments can be related to elastic curves makes the analysis on this basis quite effective, especially in view of the advantages of influence lines for all cases of moving loads, or for many loads in various positions.

The number of divisions used in the graphical construction directly affects the accuracy. In general, the length c should not exceed one-fifth to one-tenth of the total length. The number has been made relatively low in the examples here used to avoid confusing the diagrams. The true elastic curves have not been shown on these diagrams; they are curving lines drawn tangent to the polygons which have been called elastic curves.

DEFLECTION OF CANTILEVER BEAM

The simple and fundamental case of a cantilever beam loaded with a uniform load w lb. per foot throughout and concentrated loads W_1 and W_2 is shown in Fig. 1, and the elastic curve for deflection below the fixed end B is directly obtained. The force polygon and moment diagram require no explanation. Note that negative forces and bending moments are always plotted downward. Having plotted the moment diagram, either scale off the intercepts i and divide by the ratio r by slide rule, or use the graphical method indicated on the figure when the same scale is used to plot the i/r load line, K_1L_1, the values being transferred by dividers. The value of r can be laid off to any convenient scale on either side of the ordinate i.

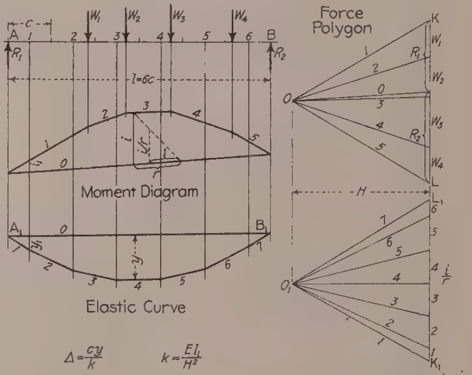


FIG. 2—DEFLECTION OF SIMPLE BEAM

The accuracy of the figures, of course, depends upon the scales used and the care with which the intersections are determined. Steep inclinations and the resulting indefinite intersections should be avoided by a proper selection of the pole.

DEFLECTION OF SIMPLE BEAM

The usual case of a simple beam supported at the ends is treated in Fig. 2, concentrated loads only being used in order to simplify the construction. The pole O is selected opposite assumed values of the reaction to give a nearly horizontal closing line. After plotting the values of i/r, the pole O_1 is similarly selected on an assumed horizontal ray, in this case ray 4, in order to give a closing line, A_1B_1, representing the original unstrained position of the beam, in a nearly horizontal position.

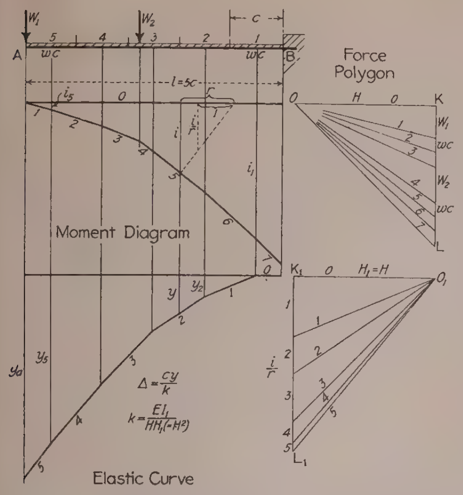


FIG. 3—INFLUENCE LINES AND DEFLECTION FOR BEAM FIXED AT ONE END

It should be noted that in all cases the values of i are assumed to represent the average for the length c considered. When sharp breaks occur at concentrated loads, the resulting error in using this average i may be large. It can be reduced by assuming a slight correction in plotting to make the plotted value more nearly represent the average for the division. The true elastic curve is, of course, a curving line tangent to the polygon shown in the diagram, and the deflection at any point is computed from the corresponding ordinate y as noted.

Beam Fixed at One End

The reactions in this case are statically indeterminate and can be obtained accurately only after a preliminary design, as in the case of all such structures. The general principles applied in the articles above mentioned are used in this case by considering the reaction R_1 at the supported end A, Fig. 3, to be the unknown, applying a unit load at A, and plotting the elastic curve for that load acting on a cantilever fixed at B. Since the bending moment is then the distance, x, from the end A, the bending moment diagram is not drawn, but values of x/r are computed and plotted on the load line as shown. Using the arbitrary pole O_o and pole distance H_o, the elastic curve for unit load at A is drawn.

This curve is the influence line for the reaction R_1. Since deflections vary directly with the loads, and since, by Maxwell's principle, any load W at any point x produces the same deflection at A as is produced at the point x by a load W at A, which would be Wy, the reaction R_1 necessary to cause zero deflection at A will be

$$R_1 = Wy/y_a$$

The unit-load elastic curve is therefore the unit-load influence line for the reaction R_1, which can be computed in the usual manner, indicated on the figure.

The deflection under the given loading is found by the elastic curve drawn parallel to the rays with pole distance O_1 and load line i/r. The intercepts i are obtained from the moment diagram constructed graphically after computing the value of the reaction R_1. The elastic curve should check by showing zero deflection at the supported end, and the value of the deflection can be computed.

The influence lines for shear, S, and bending moment, M, at any section are easily drawn on the reaction influence line as a base, as shown on the figure, noting that this curving base replaces the usual straight horizontal base line.

Effects of Settlement—Moment of Inertia

If the support at A should settle downward more than the fixed-end B, the reaction at A would decrease. Calling s the relative settlement of the support, positive if B settles more than A, and negative if A settles more than B, the reaction, R_1, due to settlement is

$$R_1 = s/\triangle_a = sk/cy_a$$

This value is independent of the loading and is added algebraically to the reaction due to loads, which is obtained by the influence line. The effects upon shear and bending moment at any section can easily be computed.

In computing the moment of inertia for built-up steel beams, deduction should be made for rivet holes in the usual manner, and since many sections will be subjected to negative bending moments, it is best to allow for the holes in both top and bottom flanges. For the case of reinforced-concrete beams, care must be taken to approximate to the action of concrete in tension, and all sections at which the maximum tensile unit stress in the concrete is less than its ultimate strength should be considered with the concrete acting and full moment of inertia used. For other sections only compression concrete and tensile steel should be included in the computation.

Beam Fixed at Both Ends

The relatively simple graphical construction shown in Fig. 4 for a beam fixed at both ends enables the unknowns R_1 and M_1 to be computed from the influence lines as noted. The theory is based upon the fundamental equations for vertical deflections and for change in angle of slope of the end tangents to the neutral curve. Assuming fixed ends and no vertical settlement of supports, the total relative deflection, $\triangle$, between the ends should equal zero and the total change in angle, φ, should equal zero. Using the equation for vertical deflection and noting that, for a single load W,

$$M = M_1 + R_1x - Wx^1$$

there results:

$$\triangle = \int_A^B \frac{Mx\mathrm{d}x}{EI}$$

$$= \int_A^B (M_1 + R_1x - Wx^1)\frac{x\mathrm{d}x}{EI} = 0$$

Since M_1 is constant, the first term can be eliminated by shifting the origin for x to the center of gravity of the values $\mathrm{d}x/r$, which will practically always be at the center line of the span, since then

$$\int_A^B \frac{\mathrm{d}x}{r}x = 0, \text{ and} \int_A^B M_1\frac{x\mathrm{d}x}{EI}$$

$$= \frac{M_1}{EI_1}\int_A^B \frac{\mathrm{d}x}{r}x = 0$$

The value of R_1 can then be obtained by solving the first equation, and the usual substitutions made to give summations, whence

$$R_1 = \sum W\frac{x}{r}x^1 \Big/ \sum_A^B \frac{x}{r}x$$

These products and summations can be obtained graphically by plotting x/r as a load line, noting that x^1 is zero for all points to the left of the load, and therefore the summation in the numerator is only carried up to the load, as given by the graphical construction. Hence, choose the pole O_o with a convenient pole distance H_o, and lay off x/r as a load line. It is convenient to begin the polygon at the center line and make ray 3 horizontal as shown, then check by symmetry. Note that x is measured from the center line or center of gravity of the values $\mathrm{d}x/r$. The resulting polygon gives the influence line for R_1, since by graphical summation the numerator of the equation for R_1 becomes WyH_o, and the denominator becomes y_aH_o, therefore, using the summation sign to include all loads on the span, the reaction is:

$$R_1 = \Sigma Wy/y_a$$

A relative settlement, s, of the support A above B would induce a reaction R_1 found by equating the fundamental deflection equation to s. By substitution and reduction, there results

$$R_1 = sEI_1/c\sum_A^B \frac{x}{r}x = \frac{sEI_1}{cy_aH_o}$$

To obtain the unknown fixing moment M_1 use the second condition that

$$\varphi = \int_A^B \frac{M\mathrm{d}x}{EI} = \int_A^B (M_1 + R_1x - Wx^1)\frac{\mathrm{d}x}{EI} = 0$$

With the origin at the center line and the constant R_1, the second term containing R_1 will vanish, since

$$\int_A^B R_1x\frac{\mathrm{d}x}{EI} = \frac{R_1}{EI_1}\int_A^B \frac{\mathrm{d}x}{r}x = 0$$

The value of M_1, however, must be replaced by M_1^1, such that

$$M_1 = M_1^1 - R_1l/2$$

to allow for the shifting of the origin of co-ordinates to the center of gravity. Solving for M_1^1, after substituting $\mathrm{d}x = c$ and $I = rI_1$, there is found

$$M_1^1 = \sum W\frac{i}{r}x^1 \Big/ \sum_A^B \frac{i}{r}$$

The second polygon with i/r as a load line is drawn as shown with pole at O_m, and pole

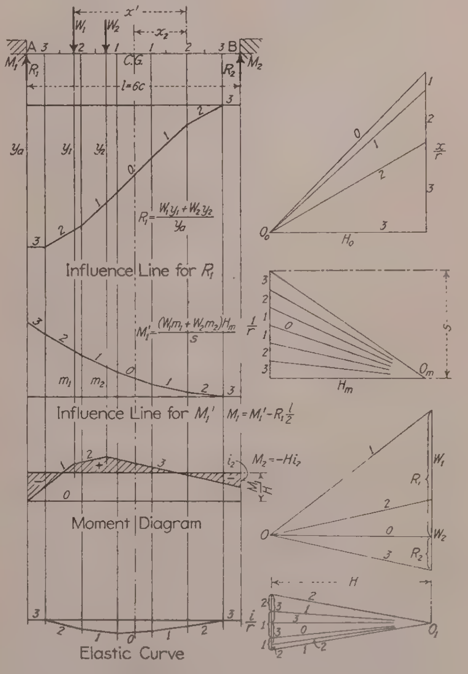


FIG. 4—DEFLECTION OF BEAM FIXED AT BOTH ENDS

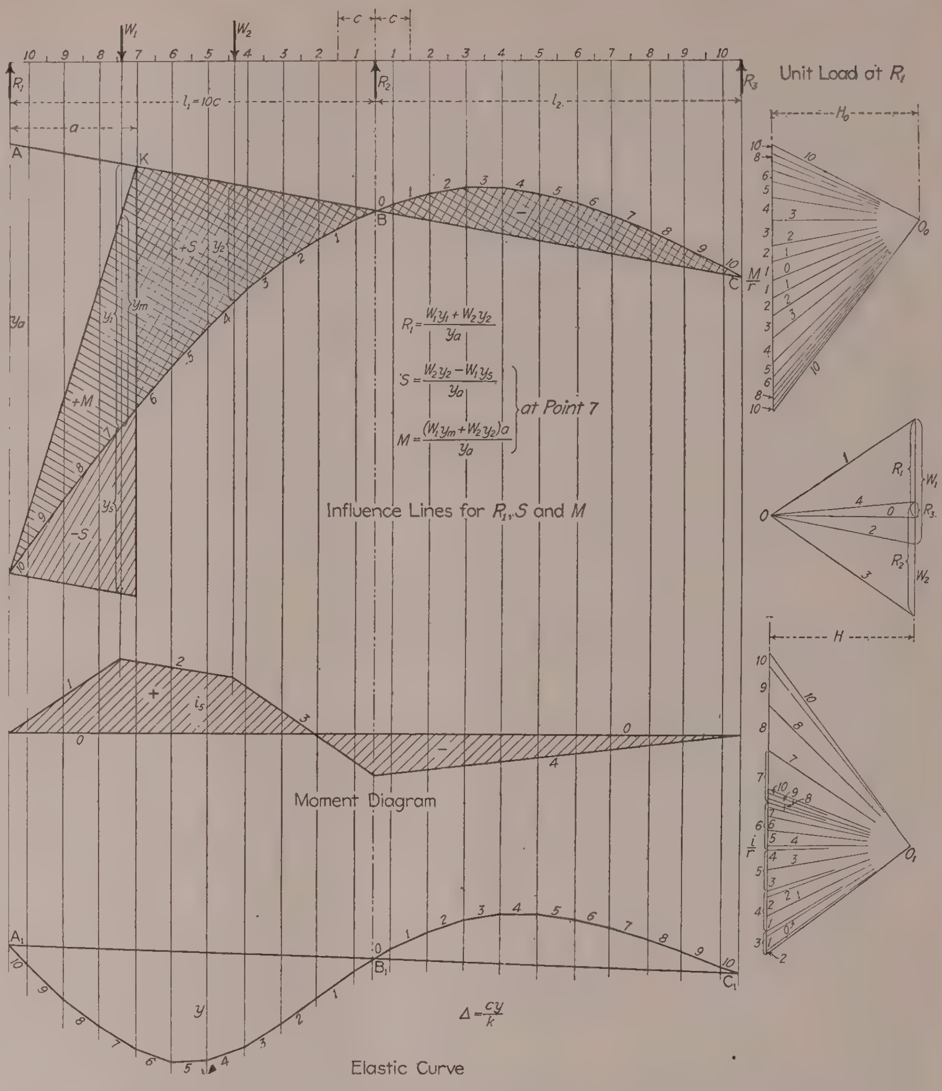


FIG. 5—INFLUENCE LINES AND DEFLECTION FOR CONTINUOUS BEAM OF TWO SPANS

distance H_m. Then, calling m the intercept, and S the summation of i/r, the general value for M_1^1 is:

$$M_1^1 = \Sigma W m H_m / S$$

for all loads on the span. Then M_1 can be computed from the formula given above.

The bending moment diagram for any given loading can be drawn, as indicated by the third pair of diagrams, Fig. 4, after R_1 and M_1 are computed from the influence lines. The value of M_2 should be computed analytically for a check, and compared with the graphical value, Hi_2. The elastic curve is then drawn as already described, and the deflections, which are seen to be relatively small, can be computed as before.

CONTINUOUS BEAM OF TWO SPANS

The influence line for reaction R_1, shear S and bending moment M for a continuous beam of two spans with variable moment of inertia has been drawn in Fig. 5. This example is the same as that used in Vol. 2, page 39, of "Modern Framed Structures" and in a paper[4] by the writer in the Transactions of the American Society of Civil Engineers, Vol. 76, page 785. The elastic curves for unit load at R_1, drawn as in the preceding cases on the assumption that the beam is supported only at R_2 and R_3 as a cantilever, is the influence line for the reaction R_1, as proved in discussing the beam fixed at one end. The values for M/r have been computed, the values of M being so easily obtained for this case. The base line for the ordinates y of this curve is located by connecting the points B and C, giving the closing line representing the original position of the straight beam, since the supports at R_2 and R_3 are assumed to be rigid, and therefore no deflections occur at these points. Although the scales used in the diagram are not large, the results check within 1 per cent the values obtained for uniform loading in the analyses above referred to.

A good check of the graphical construction for all cases of beams symmetrical about the center support B can be obtained by joining A_2 and B by a straight line and measuring ordinates from this line to the influence line. They should check the symmetrical ordinates for negative reaction R_1 on the right of B. This is due to the fact that the straight line BA_2 is the influence line for the reaction of a simple beam AB, and this reaction is too large by the value of the negative reaction produced by the effect of the negative bending moment at B, and this negative reaction is given by the ordinates on the right when the beam is symmetrical.

The deflection at any point for any given loading can be obtained from the elastic curve, constructed as already explained. The diagram gives this curve for the assumed case of two concentrated loads W_1 and W_2 on the left span. The load line is plotted, using R_1 as computed from the influence line and selecting the pole O on the horizontal ray 0. The unknown reactions R_2 and R_3 are obtained by ray 4 parallel to the closing line 4 of the moment diagram. The values i/r are then computed, or obtained graphically, and plotted as a load line, negative values downward, the pole O_1 selected with the same pole distance as before, and such that ray and side 4 on the right are horizontal (assumed) in order to give an approximately horizontal closing line $A_1B_1C_1$. A conclusive check is obtained for the graphical construction by noting that points A_1, B_1 and C_1 should be on the same straight line representing the original position of the unstrained beam.

If the support at R_1 should settle a distance s_1 with respect to the supports at R_2 and R_3, negative if downward, the resulting reaction would be

$$R_1 = s_1/\Delta_a = s_1k/cy_a$$

Similarly, if the support at R_3 settles the distance s_2 with respect to that at R_2, negative if downward, the induced reaction is

$$R_1 = s_2l_1/l_2\Delta_a = s_2l_1k/l_2cy_a$$

The influence lines for shear, S, and bending moment, M, at any given section can be drawn in the usual manner, noting that the reaction influence line really corresponds to the base line of the usual construction. For example, the shear influence line for point 7 is found by the line drawn through A_2 parallel to the straight closing line A_1B_1 and the value of S for the loading shown is as given. The bending moment influence line for this point, which is located a ft. from the end, is drawn by connecting A_2 and K, and its value is given by the formula in the figure. It is generally easier to use equivalent uniform loads and the area under the influence line; the total area for the reaction R_1 is first obtained and the triangular areas easily deducted for the computation of the bending moment.

CONTINUOUS BEAM OF THREE SPANS

The influence line for the reactions R_1 and R_2 of a continuous beam of three spans are drawn in Fig. 6. This construction is made by first drawing the elastic curve A_1B_1CD for a unit load at R_1 in the usual way, as indicated by the polygon drawn with pole O_0. In drawing these polygons great care must be used, and large scales are preferable. In order to decrease the inclinations, the pole is assumed on a horizontal ray, 0, between the two points or values 1. This line is drawn first, and the polygon continued each way from the point C. A relatively short pole distance should be used in order to give larger intercepts.

The beam is assumed to be a cantilever supported at R_3 and R_4, and the moments and values of M/r easily computed. The closing line through the points D and C represents the original position of the unstrained beam and the ordinate y under any given load W, is measured from it. The distance AA_1 is y_1 and BB_1 is y_2. The theory upon which the succeeding construction is based is as follows: A second elastic curve can be drawn for a unit load at R_2, using the same pole distance. Let y^1 be the resulting ordinate under the load W, y_2^1 the ordinate at R_2, and y_1^1 that at R_1. Then, by the fundamental relation between deflections at these points, using Maxwell's principle, the total deflections at A and B under the action of the given load W and the reactions R_1 and R_2 must be zero, and there can be written

$$Wy - R_1y_1 - R_2y_2 = 0$$
$$Wy^1 - R_1y_1^1 - R_2y_2^1 = 0$$

These two equations can be solved for the unknown reactions, which are found to be

$$R_1 = \frac{yy_2^1 - y^1y_2}{y_1y_2^1 - y_1^1y_2}W$$

$$R_2 = \frac{y^1y_1 - yy_1^1}{y_1y_2^1 - y_1^1y_2}W$$

The construction could be made on this basis and values for the reactions computed. A beam of any number of spans could be treated similarly.

To draw influence lines, however, it is possible to simplify these expressions. For the case of reaction R_1 make the construction such that $y_2 = y_2^1$, and the equation reduces to

$$R_1 = \frac{y - y^1}{y_1 - y_1^1}W = \frac{y - y^1}{y_a}W$$

or, the difference of the ordinates represents the influence line, as shown in Fig. 6. Similarly for R_2, by making $y_1 = y_1^1$ there results

$$R_2 = \frac{y - y^1}{y_b}\ W$$

and the influence line can be directly obtained, as shown.

In order to make $y_2 = y_2^1$, it is necessary to pass the second polygon through the three points B_1, C and D. This is done by graphical construction, using the trial pole O_t. The closing lines of the polygons $B_2C_2D_2$ locate the points e and e_1, which then give the desired pole O_1 by the lines parallel to the true closing lines B_1C and CD. A careful construction of the polygons is necessary, and, of course, a check results when the final polygon is drawn—it must pass through the three given points. The difference between the ordinates of the two polygons, as shown hatched, then gives the influence line for the reaction R_1, which can be computed as indicated.

A similar construction, unit load at R_2, and the polygon passing through the points A_1, C and D gives the influence line for the reaction R_2, the polygon being drawn with pole O_2 found as before, using the closing line A_2C_2 to locate e_2.

Influence lines for shear and bending moment at sections in the span l_1 can be drawn on the reaction influence area for R_1 exactly as in the previous case of a two-span beam. For sections in the span l_2, however, it is best to compute the values of R_1 and R_2 from the influence lines, and the corresponding values for shear and bending moment, and plot the results.

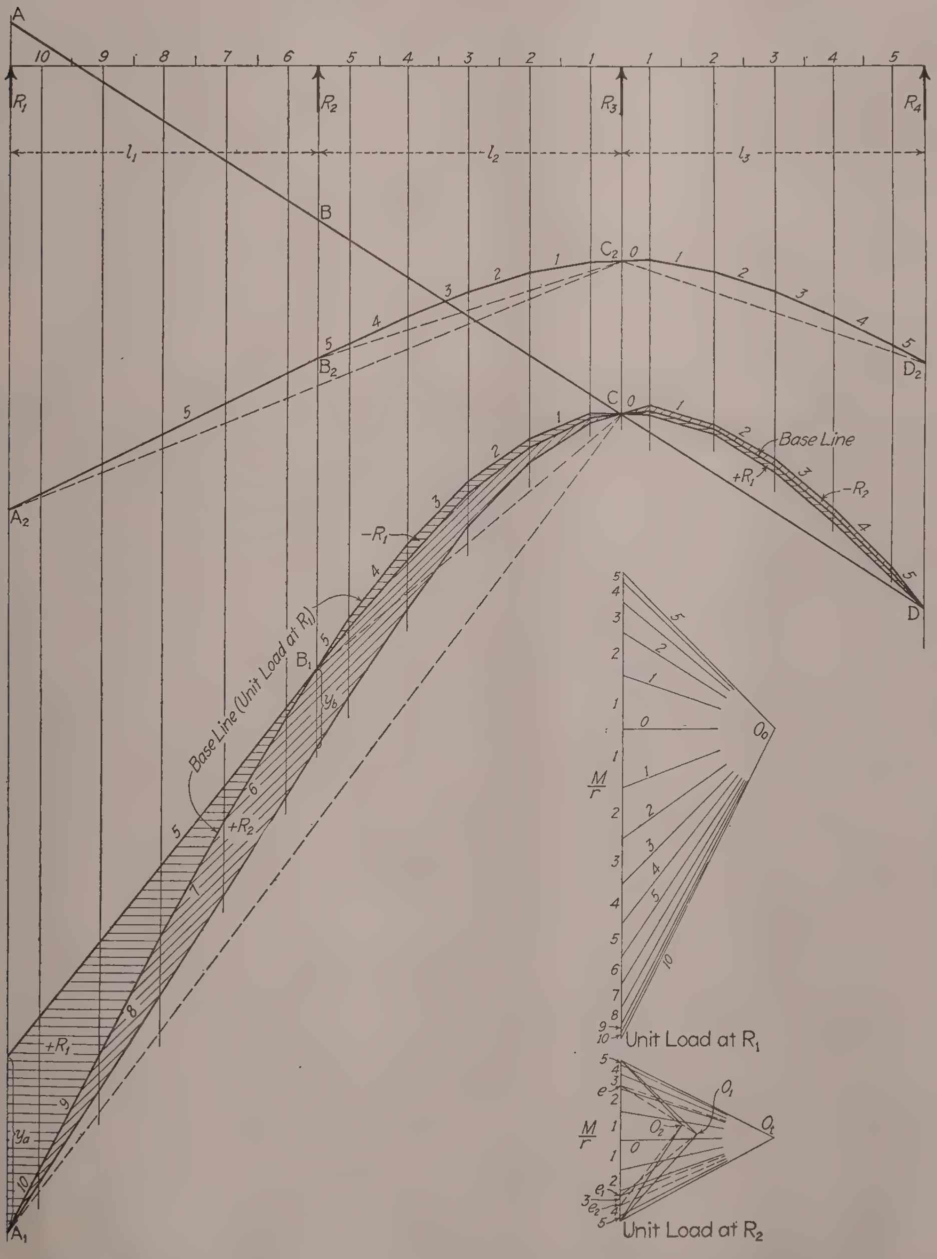


FIG. 6—INFLUENCE LINES FOR REACTIONS OF CONTINUOUS BEAM OF THREE SPANS

If the deflections are desired, they can be obtained exactly as previously described for the two-span continuous beam, the bending moment diagram being plotted graphically, and the unknown reactions R_3 and R_4 found by a closing line in the moment diagram, as in the previous case.

Electric Trucks Save Money at Panama Terminal

Twelve Have Proved So Effective in Four Months of Operation That the Panama Railroad Will Order Twelve More

TWELVE electric trucks in operation by the Panama Railroad on the piers of its Atlantic terminal have so far justified themselves that specifications are being prepared for twelve more. The performances of the trucks are described in a recent issue of the *Canal Record*. The change has effected a great reduction not only in cost, but also in time of handling cargoes. They are used not only on the piers, but between them and in the streets.

Before the electric trucks were placed in use the handling of cargo at the terminals was done entirely by means of two-wheeled push trucks for pieces weighing up to 500 lb., with locomotive cranes and flat cars for the unusually large and heavy pieces. At times there were as many as 1200 trucks and truckers employed, and the average was about 500. With wages of 90 cents a day for each trucker this meant about $450 per day.

EACH TRUCK CAN SAVE $19 PER DAY

Each of the electric trucks has been found to take the place of at least twelve men, or in a day-and-night shift operation to supplant about twenty-five men. The cost of operating the trucks during the 24-hr. day is approximately $3.50, of which $2 is for the operators, one to a shift, $1 for charging the storage batteries, and 50 cents for the interest on the investment and the wear and tear on the machine. In a double-shift day each truck thus effects a saving of about $19. The trucks are employed constantly, and the fluctuations in cargo are met by variations in the employment of the push trucks.

The electric trucks handle from 4000 to 6600 lb. per trip, and move at speeds varying from 8 to 12 miles per hour. Three types are in use. Four use trailers and haul 6600 lb. at 8 miles per hour. Three carry 4000 lb. and make 10 miles. Five carry 4400 lb. and make 12 miles.

The relatively great capacity and speed of the trucks allow them to be used to a large extent in place of railway cars for handling cargo between piers. Where cargo is transferred from a vessel at dock 10, for instance, to one at pier 8, the goods may be loaded on trucks, which will make the run of approximately 2000 ft. in three or four minutes, and handle the cargo more quickly than it could be handled by train. This eliminates much switching, with the delays incident to waiting for cars and engines, and saves a great deal of rehandling. Frequently cargo can be delivered to a truck in the sling into which it was loaded in the hold of the ship, hauled to some other point at the terminal and swung from the truck into another vessel in the same sling. When refrigerated goods for the commissary branch are unloaded the trucks can carry them direct to the cold-storage plant.

The trucks run very satisfactorily on the streets.

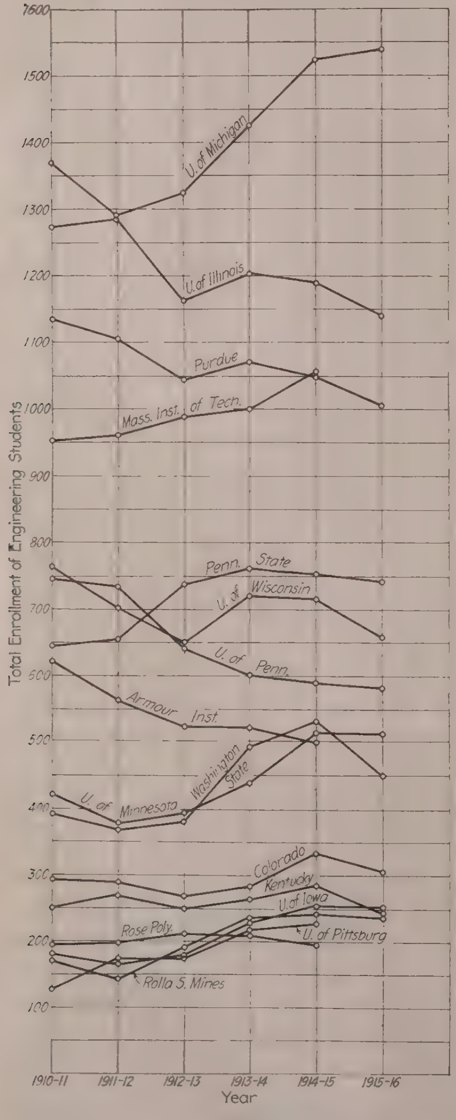
In connection with the use of the trucks, states the *Canal Record,* new short cuts for efficiency are being originated almost every day in meeting the various transfer problems. When the Panama Railroad vessels from the United States bring mail the trucks go to the ship's side and handle the packages quickly to the several cars of a special train. Goods for the line commissary are handled from the ship to cars designated for various towns; it is not necessary to take them first to the general warehouse. Local cargo for Colon is handled as unloaded direct to the land end of the pier, whence it can be taken by cartmen with a minimum of delay and confusion.

In many ways the trucks allow the substitution of a relatively few speedy units of large capacity for many units slow in their movements interfering with one another by their very numbers, and in need of constant supervision and speeding up.

Registration in Civil Engineering Is Decreasing

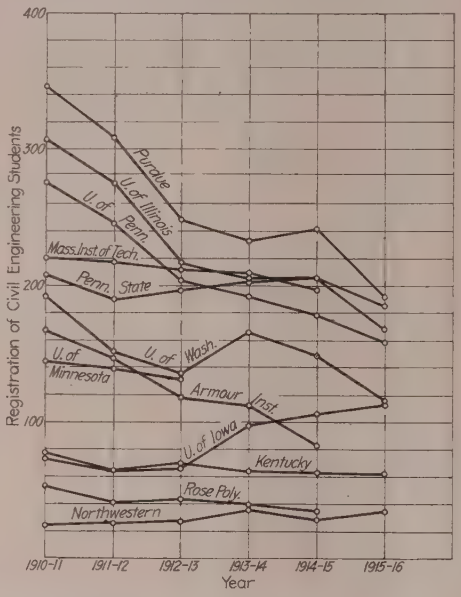
Statistics Indicate That Condition Is Not Local—East and West Show Similar Decline

FOR some years professors of civil engineering have been noting, in the Middle West particularly, the apparent decline in interest in engineering. The measure of this decline has been the decrease in the number of students in the engineering courses. Just how serious the decrease has been is evident from the curves presented herewith.



ENROLLMENT OF ALL ENGINEERING STUDENTS SHOWS NO GENERAL DOWNWARD TENDENCY

Taking first the curve of enrollment of all engineering students, it is apparent that while, in the sum, the decrease is considerable, there are good growths in some of the institutions. The downward trend of the curves for Illinois, Purdue, University of Pennsylvania and Armour Institute are counterbalanced by the very surprising curve for the University of Michigan, and the good growths of Massachusetts Institute of Technology, Pennsylvania State, Washington State, Minnesota and the 200-300 enrollment group. The sharp falling off in this year's registration is general, except for Michigan and Massachusetts Tech, though the figure for the latter is not plotted.



ENROLLMENT OF ALL STUDENTS IN CIVIL ENGINEERING SHOWS SHARP AND PERSISTENT DECLINE

Civil Engineering Registration

When the curves of registration in civil engineering are taken up, however, the conditions appear to be more serious. Considering the curve for total registration of civil engineering students, for example, it will be noted that, with the exception of the University of Iowa, there has been a general decline, most serious in the Middle West, though, as in the previous diagram, experience at the University of Pennsylvania is similar to that in the Mississippi Valley.

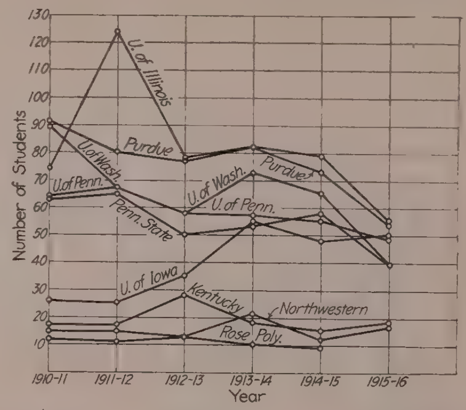
The final set of curves, that of the registration of freshman civil engineers, is the most serious of the three. The preceding diagram still shows in the figures for 1915-16, the fairly good freshman registration of 1912-13. Should the present trend persist the small registration of freshmen in 1915-16 presages very sharp declines in total registration two, three and four years hence. This is a serious matter for colleges equipped and manned for double the number of students that are in prospect.

Discussion Invited

The matter is giving serious concern to professors of engineering throughout the country. So far no one has proposed an explanation that is entirely satisfying to others studying the problem. The Engineering Record therefore, invites discussion from its readers, both in the colleges and in practice, on these points:

1. What is the cause or causes of the decline?
2. What is the remedy?
3. While the situation is alarming from the point of view of the colleges, is it so from the point of view of the practitioner? In other words, is the field oversaturated and will the profession be benefited by reduction in the supply of young engineers?

Some views on the matter will be found in the editorial pages of this issue.



NUMBER OF FRESHMAN CIVIL ENGINEERS PRESENTS MOST SERIOUS CONDITION, PRESAGING STILL SMALLER TOTAL ENROLLMENT IN NEAR FUTURE

Burn Typical Office Equipment in Test Room

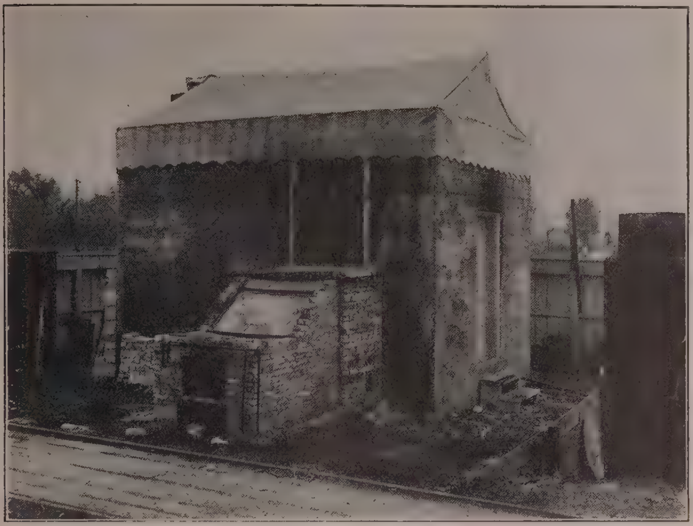
Forest Products Laboratory, in Fire-Test House, Investigates Temperatures and Inflammability of Treated and Untreated Wood

FIRE tests on a typical office room with its usual complement of equipment have recently been carried out at the Forest Products Laboratory at Madison, Wis., as part of an investigation of the fire-resisting properties of treated and untreated wood. These tests have been in progress for two years, the first data being obtained on the relative burning points of treated and untreated wood. The fire-test house consists of a room constructed of cinder concrete and furnished with wood floor, trim, furniture, window casings and doors. It measures 12 x 16 ft. in plan, in side dimensions, and 10 ft. high. Books and papers were scattered around the room in exposed places, and one book case was filled with books.

Waste Paper Basket Would Not Start Fire After Four Attempts

In the first series of tests all the wood in the interior of the room was untreated but was given a coat of varnish. A fire was started in a waste paper basket so placed that it would communicate with a desk. Four attempts were made to burn the contents of the room by means of burning up the waste paper basket. In each case the basket burned out without igniting the furniture or destroying any of the contents of the room. During these four attempts various conditions of air control were obtained by conducting the test first with the windows and doors closed and later partly or entirely opened.

It was found necessary in order to destroy the contents of the room to supply heat from the outside. A furnace was built adjacent to one of the windows and arranged to admit air highly heated by means of two crude oil burners. This air was admitted to the room for 18 min. with door and window closed. It was found necessary to open the door and admit fresh air before combustion would take place. With the admission of fresh air the room immediately burst into flames. Within less than an hour after the first flame was noted the contents of the room were totally destroyed.



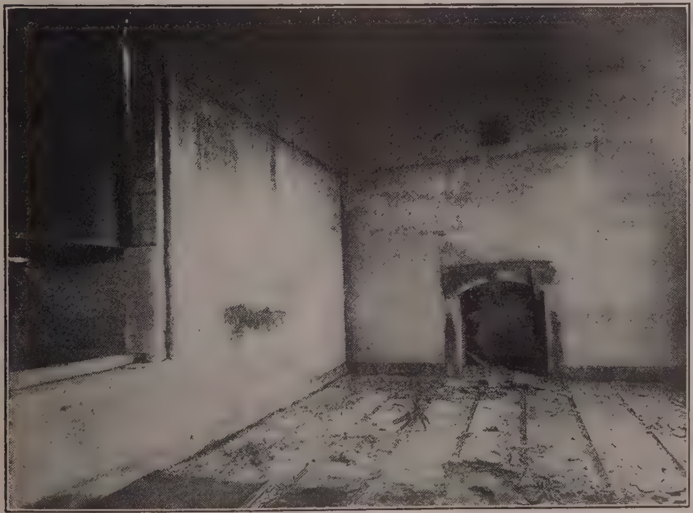
OIL FURNACE SUPPLIED HEAT FOR FIRE-TEST HOUSE

FOUR ATTEMPTS TO START FIRE FROM BASKET FAIL

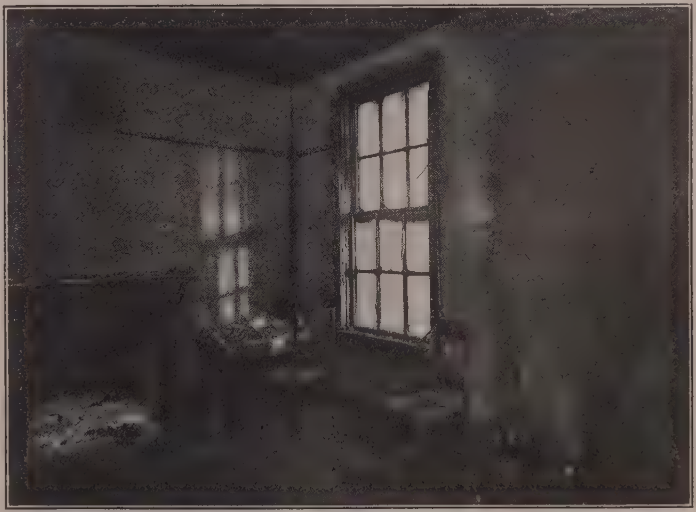
TRY AMMONIA SALTS AS FIRE RETARDANT

The room was then refitted in exactly the same manner, but with wood which had been treated with ammonium phosphate and ammonium sulphate to render it fire retardant. One small table and a chair of untreated wood were included to make certain that the conditions were such that untreated wood would burn. The test was repeated as in the above case. After about 15 min. of exposure to the heated air from the crude oil burners the door was thrown open to admit fresh air. This did not cause the contents to ignite, however, and the door was closed for another 15 min. It was then opened, and the untreated table and waste paper basket ignited and burned vigorously. All of the papers on the desk and the untreated table and untreated chair were very soon destroyed. The treated wood which was in contact with large masses of burning papers and books, such as the desk and the bookcase, was also gradually destroyed, but not until long after the untreated portions were consumed. After 3 hours the room was entered and photographs taken showing its condition after the test.

The test showed that the treated wood carbonized and gradually burned up when in contact with burning papers. Treated wood not in contact with combustible material did not support combustion, but was carbonized. The mass of carbonized material in the lower right-hand corner is what remains of the books and bookcase. This debris fell around the treated chair without destroying it. Accurate temperature measurements were taken at several points in the room at frequent intervals. The results are now being analyzed and will be reported on later.



ALL UNTREATED WOOD IN THE TEST ROOM BURNED

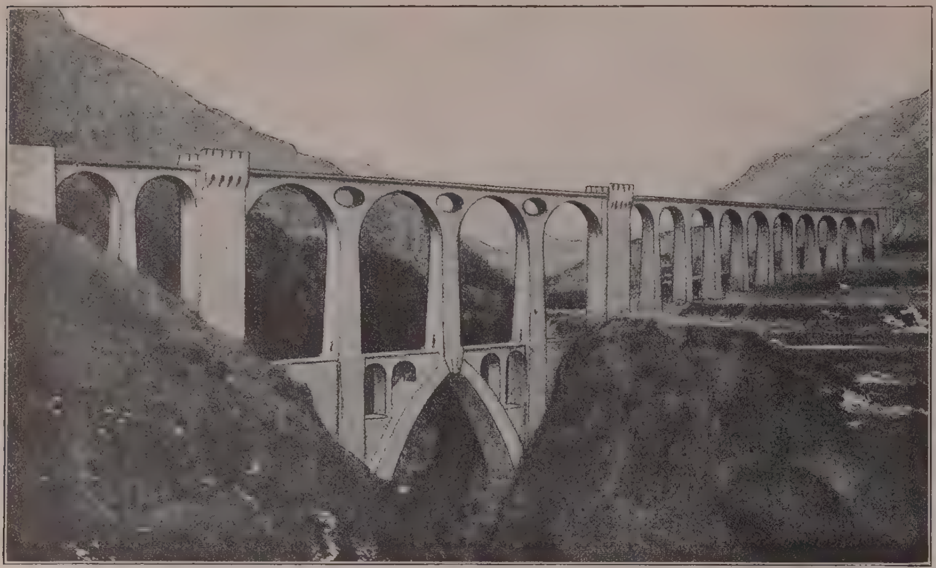


AMMONIA SALTS SAVE ALL BUT DESK AND BOOKCASE

September Railroad Operating Income Shows Marked Increase

GROSS operating revenues for September on the large steam railroads of the United States, according to a bulletin issued by the Bureau of Railway Economics, were $1,251 per mile, showing an increase of $66 or 5.6 per cent as compared with September, 1914. Operating expenses were $774, a decrease of $9 or 1.1 per cent. Net operating revenue, therefore, was $477—an increase of $75 or 18.6 per cent, and operating income was $426—an increase of $74 or 20.9 per cent. The Southern district was the chief beneficiary of the marked increase in net returns, its increase in operating income being 48 per cent. September, 1914, however, was the lowest September in the South for the last six years. The operating ratio for the whole country was 61.8 per cent, as compared with 66.0 per cent in September, 1914, and 69.6 in September, 1913. Considering the three main districts, the respective ratios for September, 1915, and September, 1914, were as follows: Eastern district, 62.5 and 67.9; Southern, 66.7 and 74.6; Western, 59.5 and 61.4.

A CHLORINATION PLANT AT SACRAMENTO, CAL., was installed in the water-supply system early in 1915. After several months of use the local typhoid cases reported were found to be 73 per cent less than for the corresponding period of 1914.



TWO-LEVEL ARCHED VIADUCT OF MASONRY CROSSING THE TET RIVER IN FRANCE

High Masonry Arch Viaduct in France Designed as a Two-Level Structure

Fontpedrouse Viaduct for Electric Railway Contains Central Pier Supported on Crown of Lower Arch Spanning Deep Ravine of Tet River

A MODERN VIADUCT of granite masonry designed with remarkable architectural effects to conform to the rock profile and the natural beauty of the site is the new Fontpedrouse structure over the Tet River in France. Its masonry arches are supported on high piers, one of which is itself carried on the crown of a pointed arch below. A description of this structure, which was designed by Professor Sejourne, is given by A. Dumas in *Le Genie Civil* for Nov. 6, 1915. The photograph and general elevation here reproduced show the extraordinary character of this modern construction and its resemblance to the old Roman aqueducts.

The bridge is one of two structures, the other a steel suspension bridge, which carry across the Tet River the electric railway which was recently built from Villefranche-de-Conflent to Bourg-Madame. It is notable in two principal features—the designer has spanned the lower narrow ravine by a 98½-ft. pointed arch upon the keystone of which a high intermediate pier of the main arch viaduct is supported, and he has decreased the cost of the main arches by reducing their width to the minimum compatible with the lateral stability and the general magnitude of the structure by carrying the walkways on an overhanging reinforced-concrete floor slab supported on cantilever beams.

The number and span length of the masonry arches composing the main high-level viaduct are shown on the general elevation. The height of base of rail above the river is nearly 225 ft. High, massive towers with battlemented tops serve to divide the main structure from the arch approach at each end. All four of the main arches are of the same clear span, about 56 ft., with full-centered circular intrados. Spandrel arches are used in the solid rubble masonry, spandrel filling for both the upper and lower arches, as shown, and a continuous walkway provided at the lower level, with openings in the main intermediate piers. The viaduct is on a grade of 6 per cent, and the approaches consist of circular arch spans, about 29½ ft. clear between piers, two on one side and ten on the other.

The four main arches are 8.2 ft. wide at the top, which is sufficient to carry the narrow-gage electric track and provide for the walkways about 2.5 ft. wide on each side by cantilever brackets, as shown in the cross-section herewith. This total width of arches and piers increases at a constant batter to 13.65 ft. at the bottom of the high pier over the lower arch. This lower pointed arch is 17.3 ft. wide at the crown and 22.15 ft. wide at the springing line, with a thickness of 8.2 ft. at the crown and 11.5 ft. at the springing line.

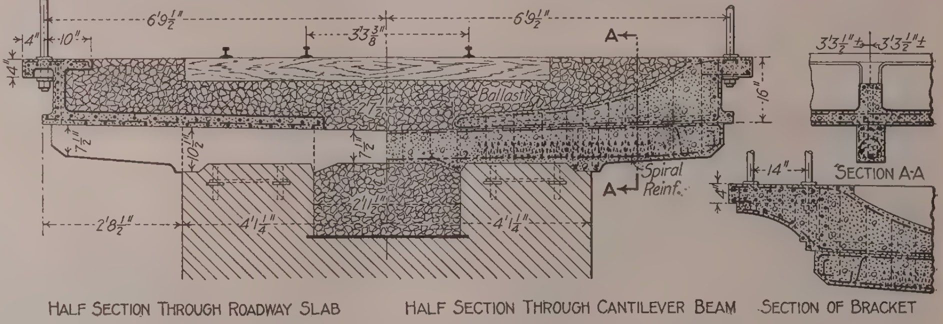
MAXIMUM STRESSES

The maximum stress at the time of striking centers for the lower pointed arch was computed to be about 206 lb. per square inch. This decreases under service conditions to 175 lb. per square inch at the springing line and 142 lb. at the crown. These figures increase to nearly 200 lb. and 242 lb. respectively when the temperature rises 10 deg., and decrease slightly when the temperature decreases.

In the four main 56-ft. arches the maximum pressure is nearly 370 lb. per square inch at the springing and 440 lb. at the crown. These high figures are admissible because of the excellent granite used, and the exceptional quality of the construction work.

REINFORCED-CONCRETE DETAILS

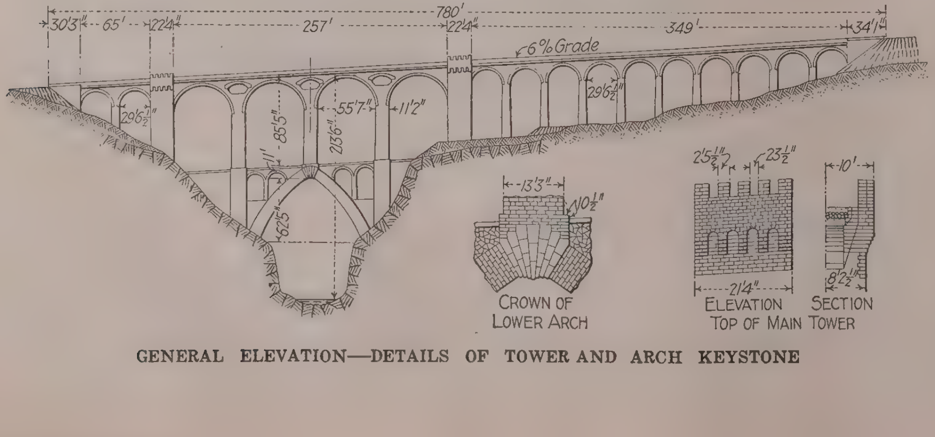
Ballast for the railway track is carried by the overhanging reinforced-concrete slabs shown in the accompanying sections. An unusual feature is the use of spiral reinforcement in the lower sections of the cantilever beams. These beams are spaced about 3.3 ft. apart, and at intervals are extended about 14 in. farther out to form refuges for pedestrians. A detail of these longer brackets is drawn. The third, or conductor, rail is shown on one side of the track and the walkways are protected by an iron railing on the outside. Steel anchor plates are inserted in the upper courses of masonry near the outside of the arch to tie effectively the edges.



HALF-SECTIONS THROUGH ROADWAY SLABS AND BEAMS

Spiral reinforcement used in lower sections of cantilever beams.

The designer of the structure, Professor Sejourne of l'Ecole des Ponts et Chaussees, always lays great stress upon the architectural appearance of his bridges. The temperature stresses were computed by Professor Pegeaud, also connected with the same institution, of Paris, France.



GENERAL ELEVATION—DETAILS OF TOWER AND ARCH KEYSTONE

ACTIVATED SLUDGE EXPERIMENTS will soon be carried on intensively by the Sanitary District of Chicago with stockyards sewage, $10,000 having recently been appropriated by the trustees for that purpose.

HINTS FOR THE CONTRACTOR

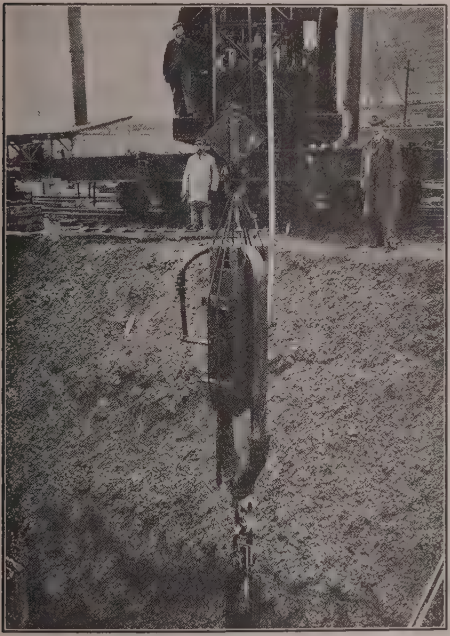
Details Which Save Time and Labor on Construction Work

Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

[*Contributions to this section are solicited, and if found available will be paid for. They must be* SHORT, *and should be accompanied, if possible, by photographs or sketches.*—EDITOR.]

Inverted Steam Hammer Pulls 35-Ft. Piles in 90 Seconds Each

AN INVERTED steam hammer has recently made the remarkable record of pulling in 90 sec. apiece 35-ft. steel sheet piling which was used in cofferdams for constructing the foundations of the Pittsburgh & Lake Erie Railroad's new warehouse in Pittsburgh. Mass concrete for the footings, 5 ft. thick, was poured directly against the sheeting with no attempt to prevent a bond, and the cofferdams were backfilled to the top before any pulling was done. Nevertheless, a majority of the piles were started and drawn in one minute less than the average driving time on each pile.



HOW STEAM HAMMER WAS RIGGED

PILES SHOWN AT RIGHT ARE NOT NEW—EVERY ONE OF THEM HAS BEEN DRIVEN AND PULLED

The rigging, plainly shown in the photographs, consisted of a wire-rope sling suspended from the crane hook supporting the inverted hammer. Over the anvil block of the latter passed a heavy strap of steel, shackled at the lower end to pulling straps pinned to the pile. The hammer, a No. 6 McKiernan-Terry, is rated at 275 blows a minute with an 8¾-in. stroke. It was supplied with steam from the crane.

This method of pulling piles, originated by Robert Melvin about a year ago in pulling sheeting for Arthur McMullen & Hoff on the Harlem River section of the new Lexington Avenue subway in New York City, is rapidly finding favor with contractors, because the piles pulled are in practically perfect condition. Mr. McKelvey of the McKelvey-Hine Company, which is carrying out the Pittsburgh & Lake Erie contract, was of the opinion that the piles would not have paid for the trouble of pulling them by other methods. Out of several car loads drawn with the hammer at Pittsburgh, however, practically every pile was in condition for immediate redriving.

Well-Pumping Difficulties Solved by Double Casings Filled with Gravel

By E. C. EATON

Superintendent of Filtration Plant, Panama-Pacific International Exposition

SAND caused a good deal of trouble in the five deep wells sunk to depths of about 80 ft. for supplying water to the filtration plant of the Panama-Pacific International Exposition at San Francisco, described in detail on page 748 of this issue. With well 1 not much difficulty was encountered, but the experiences with wells 2, 3, 4 and 5 were discouraging. It was found with all the wells that the foot-valve at first installed was an unmitigated evil. Sand in the water would gradually collect on this valve until sufficient had been deposited to hold the valve shut. The valves were accordingly removed.

A discharge of about 50 gal. per minute could be obtained from these wells for a period of a week. At this rate an appreciable amount of sand was pumped and, apparently, formed an open space around the well casing below the water line. This would hold up for several days and then suddenly break down, the ground about the well for a radius of 5 ft. dropping down or caving in when walked on. Unless carefully watched the pump would freeze up and throw the belt. Each of these four wells was sand-pumped, on an average, every 10 to 15 days, and the space around the casing where the caving occurred was kept filled with coarse sand in the hope that eventually this would collect around the outside of the casing and hold back the fine material.

As it would have been expensive to withdraw the pump and replace it for sand pumping and as there was a 2-in. space available between the pump and the casing an air lift was employed to remove the sand. An idea of the difficulty in keeping the sand from the wells may be gained when it is stated that on some occasions, when a plugging of the air lift discharge pipe occurred and a pressure of 100 lb. was put on the air pipe, the plug would suddenly clear, with a consequent rush of air through the bottom of the air lift, producing a certain amount of agitation of the water which would be sufficient to cause the sand to flow in through the casing and fill the well again to a depth of 2 ft. or more.

TEST GRAVEL AND PLATES

After nearly three months' trial the wells showed no improvement, and it was decided to drill a new well. Experiments were made with various mixtures of sand and gravel and different perforations in the well points. It was found that a naturally graded beach gravel, having an effective size of 0.42 mm. and a uniformity coefficient of 2.18, in conjunction with a perforation not over 1/32-in. wide, held back the fine material when the velocity through the perforations was as high as 0.75 ft. per second. This was considered a safe value.

Under contract the old wells cost $7.50 per foot of depth, so it was decided that a new well could be put down more cheaply by the Exposition Company, using a hydraulic ejector. Two concentric casings were sunk and the space between filled with the gravel chosen by the test above mentioned. In case of trouble due to clogging a 3-in. space between the casings was allowed, thus facilitating the removal of the sand for washing. Five days were required

TABLE 1—TEST OF NEW WELL

Discharge G.P.M	Drawdown feet	G.P.M. per foot drawdown
5	1.5	3.3
20	3.25	6.15
35	4.33	8.10
60	5.91	10.15
110	8.43	10.50
125	11.90	10.50
155	13.40	11.56
175	15.00	11.62
200	16.40	12.20

to complete this well. A test gave the following results shown in Table 1.

No sand was discharged by the well, and it was determined to overhaul the old wells and reconstruct in a similar manner. There was a 2-in. space between the inner and outer casings, filled with pea-size gravel, and an attempt was made unsuccessfully to draw the inner casing. As it was necessary to get these wells in working order in a short time, it was decided to put down a third casing inside the inner casing, having a 1-in. space between them to be filled with sand of the same grade as that used in No. 6 well.

A test of one of these reconstructed weils gave the results in Table 2.

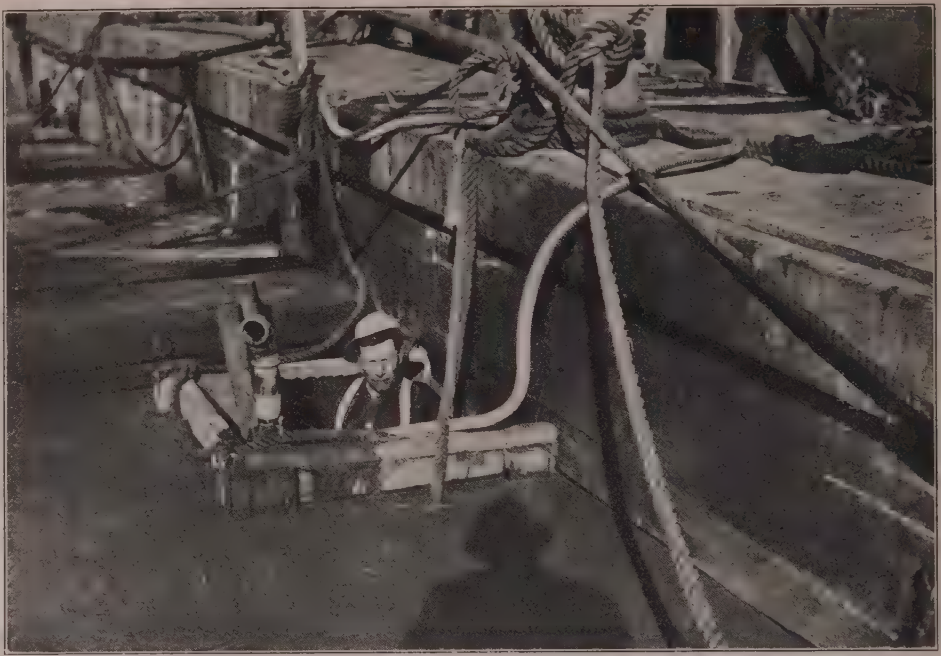
TABLE 2—TEST OF RECONSTRUCTED WELL

G.P.M.	Water levels in feet	Drop in feet	G.P.M. per foot drawdown
00	13.32	....	....
10	17.08	3.75	2.67
49	20.25	6.92	7.07
92	25.41	12.08	7.62
140	30.66	17.33	8.07
202	37.16	23.83	8.45
243	40.93	27.6	8.80

No sand was discharged at any time. The results of the experiments indicate that by an analysis of the soil in the particular district chosen it is not difficult to construct a well consisting of two casings with a sand filling at a cost of not over $4 per foot up to 100-ft. depth, in a district similar to this, and capable of delivering at least 200 gal. per minute continuously.

Inspecting and Calking Dredge Hulls Without Drydocking

A VERY simple device has been used on the fleet of dredges of the California Development Company to inspect and calk their hulls without drydocking. The company, operated by W. H. Holabird as receiver, owns and maintains the main system of canals supplying water to the Imperial Valley in southern California and in the northern end of the Mexican province of Lower California. The box, shown in the accompanying illustration, is built of 4 by 12-in. timbers and thoroughly calked. As is plain from the photograph, the long end is pushed beneath the dredge hull, the vertical leg being long enough to project above the water surface. To the edges touching the sides and bottom of the hull is nailed suitable rubber packing so as to make a water-tight seal. Once in place the inside of the box is pumped out. The water pressure against the bottom of the box clamps it so tight to the hull as to prevent any leakage. The clear dimensions inside and also the height of the vertical leg and the length of the horizontal section vary with the size and type of dredge. As a rule, however, only sufficient space is provided to give a fair amount of working room. The height of the vertical leg is determined, of course, by the draft of the dredge, while the horizontal length is determined by the beam of the boat. By the use of the device drydocking of the boats has been unnecessary, and they have been continuously maintained in service for years.



WATER PRESSURE CLAMPS MOVABLE "COFFERDAM" TIGHT AGAINST HULL

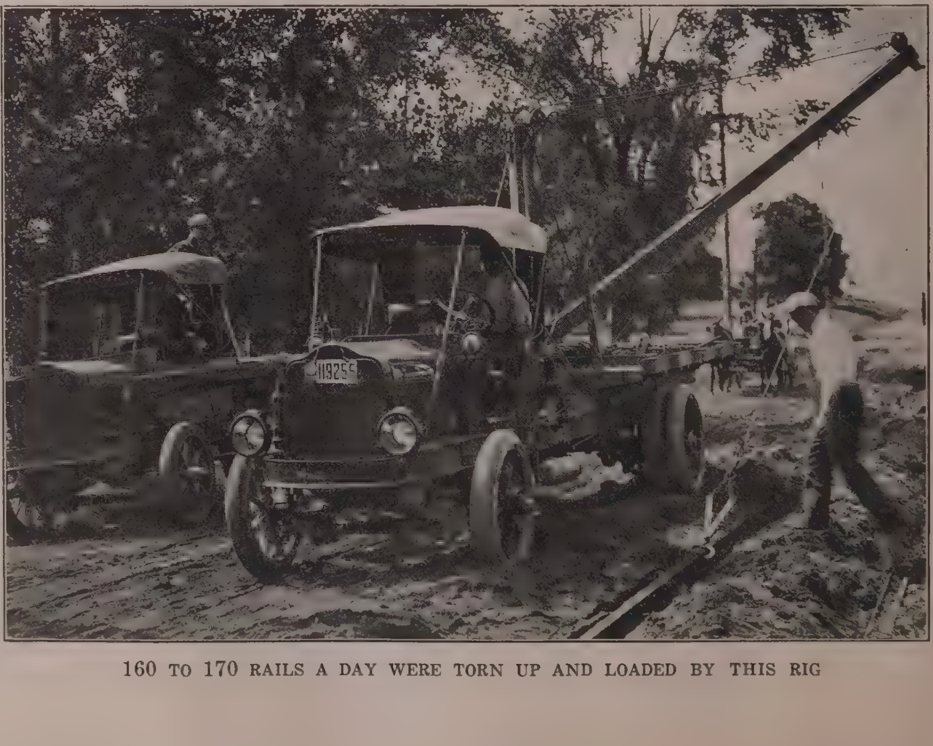
In connection with the calking of the hulls, using this device, it was found at the start that the cement placed over the calking would not hold. The scheme was hit upon therefore of tacking a light cleat over the seam as soon as the cement had been placed. This has proved effective and satisfactory.

Motor Truck Tears Up Half a Mile of Railroad a Day

THE accompanying photograph shows a portable derrick used recently by C. C. Parsons & Co. of Cleveland to tear up half a mile of track a day in removing an abandoned interurban line. The derrick, which was rigged on a White truck, was operated by the motor through a winch geared to the transmission. Where the ties were rotted, the rails and spikes were easily pulled by simply hooking on the tongs. Where the ties were still sound, the whole track came up at once when this was tried. It was found cheaper to pull the spikes first than to keep the trucks tied up while the ties were knocked loose after the track had been raised by the crane. The derrick loaded the rails on a second truck as they were pulled. It was also used to take down the old poles and cross arms.

The electric railway torn up was about 24 miles long, and was formerly operated between Chagrin Falls and Garrettsville, Ohio.

IN DRIVING CONCRETE PILES IN PIER WORK at San Francisco, the best cushion found was a coil of manila rope placed on three thicknesses of 2-in. fir plank. A single-acting steam hammer whose moving parts weighed 5000 lb. was used with a 1200-lb. follower block.



160 TO 170 RAILS A DAY WERE TORN UP AND LOADED BY THIS RIG

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

State Highway Officials Will Not Attend Two Annual Meetings

Take Steps to Bring Harmony Between Leading Organizations in Highway Field—Urge Officials Not to Appoint Delegates to Meetings Held Before Next December

The holding of two national road congresses each year was severely condemned at the meeting of the American Association of State Highway Officials in Chicago, Dec. 7 and 8. Resolutions were adopted expressing the sense of the meeting that it was opposed to the holding of any national road congress prior to Dec. 1, 1916, and binding the members of the association not to participate in any manner in any national congress held prior to that date. It was further determined that the members of the association would urge upon the executives of their States and also upon municipal officials that no delegates be appointed to any congress held prior to the date set. For the good of the road movement the association believes that the American Road Builders' Association and the American Highway Association should amalgamate into one organization or should at least arrange to hold jointly one annual road congress. If these two associations fail to arrange prior to Aug. 1, 1916, for such a joint congress to be held in December, 1916, or early in 1917, the executive committee of the highway officials' association was authorized to designate the date and place of its next meeting and to notify the above associations of the same, requesting them to hold a joint meeting at that time and place. The association stands pledged to give its hearty support and co-operation in case there is amalgamation or a joint meeting. Copies of the resolution will be sent to manufacturers, urging them to approve of the position and to co-operate in bringing about the single meeting advocated.

Resolutions were also adopted supporting the proposed federal-aid road law, which would make available Government funds each year to the extent of $25,000,000. A committee composed of George P. Coleman, highway commissioner of Virginia; E. A. Stevens, highway commissioner of New Jersey, and Henry G. Shirley, chief engineer of the Maryland State Roads Commission, was appointed to bring the proposed law to the attention of members of both branches of Congress.

The officers elected for the ensuing year were: President, Henry G. Shirley, chief engineer of the Maryland State Roads Commission; vice-president, A. B. Fletcher, California State highway engineer; secretary, J. H. Pratt, State geologist of North Carolina; treasurer, F. F. Rogers, Michigan highway commissioner. George P. Coleman of Virginia was re-elected for five years chairman of the executive committee. W. D. Sohier of Massachusetts, T. H. McDonald of Iowa, E. A. Stevens of New Jersey and Lamar Cobb of Arizona were elected members of the executive committee. S. E. Bradt of Illinois was elected chairman of the finance committee, with W. S. Keller of Alabama, P. D. Sargent of Maine and W. S. Gearhart of Kansas as members.

Would Submit Wharton Tract Purchase to Voters a Second Time

By a unanimous vote the New Jersey State Department of Conservation and Development decided Dec. 1 to recommend that the proposed purchase of the Wharton tract be again submitted to the voters of the State at the election next fall.

Water Power Bills Again in Congress

The Adamson and Ferris water-power bills were reintroduced in Congress at the opening session of that body. The former is intended to govern the construction of dams on navigable waters other than those on public lands, and has the approval of the Secretary of War and the chief of engineers of the Army. The bill has been slightly amended from the manner in which it came from the committee last year, but it will not be printed, nor will many other bills offered in Congress for a while, owing to the great number of bills introduced. The Ferris bill, which is intended to control dams on public lands, is the one which had the support of the Secretary of the Interior.

Philadelphia Engineers Made Heads of Important City Departments

GEORGE S. WEBSTER — GEORGE E. DATESMAN

Representative Adamson said in Washington during the week that he expects to pass the measure to which his name is attached at the present session of Congress. To do so he will rely for support in large measure on the statements made at last year's hearings by Hugh L. Cooper, of New York, who was largely identified with the building of the Keokuk dam. Representative Ferris also announced that he intends to push his bill at this session of Congress.

Want Mississippi River Considered Apart from River and Harbor Bill

A resolution was adopted to request all members of Congress interested in the improvement of the Mississippi River and the prevention of floods in its valley to co-operate in the preparation of a bill designed to make of such work a separate and independent project, just as was done in the case of the Panama Canal, at a conference of senators and congressmen from the riparian States with members of the Mississippi River Commission and the presidents of local levee boards, held at Memphis, Tenn., Oct. 25. Such a bill would make such improvements a matter apart from the regular River and Harbor Bill.

Important Philadelphia City Departments to Be Headed by Well-Known Engineers

George S. Webster and George E. Datesman Chief Engineer and Principal Assistant Engineer Respectively of the Bureau of Surveys Are Promoted to Important Posts

As briefly noted in this journal last week, George S. Webster, chief engineer of the Bureau of Surveys, Philadelphia, has been appointed director of the Department of Wharves, Docks and Ferries, and his assistant, George E. Datesman, has been made director of public works. The appointments have been highly praised in Philadelphia, for both engineers have proved by long service their grasp of Philadelphia's needs and their ability to execute important works in a successful manner.

George S. Webster

Mr. Webster has been chief engineer of the Bureau of Surveys for nearly twenty-three years. He was born in Philadelphia, and educated in the Friends' Select School and the University of Pennsylvania, being graduated from the latter with the degree of civil engineer in 1875.

His first work was as an assistant in laying out the grounds of the Centennial Exposition. Later he served for a brief time in the United States Coast and Geodetic Survey, and in 1877 entered the employ of the Bureau of Surveys as assistant engineer. His progress was rapid, for in 1880 he was made surveyor and regulator of the tenth survey district, a position similar to that of city engineer of a smaller town. His responsibilities for the municipal engineering work in that district being successfully discharged, he was promoted to the position of principal assistant engineer in 1892, and in 1893 became head of the bureau, which office carries with it the presidency of the Board of Surveyors, an organization having large authority and control over the surveying and engineering activities of the city.

The work of public improvement that has

been under the supervision of Mr. Webster during his long incumbency of the office he now leaves has included the establishment and extension of the street and park systems, the design and construction of all sewers and bridges, the design of a new system of sewage disposal and its inauguration by the construction of the Pennypack Creek sewage disposal plant, and the abolishment of grade crossings. Some of the principal achievements along these lines have been the construction of the great concrete arch bridge carrying Walnut Lane across the Wissahickon Ravine, the Falls, Grays Ferry and Passyunk Avenue bridges across the Schuylkill River and a large number of concrete bridges of fine design in various parts of the city. Under his charge has been the abolishment of grade crossings along the Pennsylvania and the Philadelphia & Reading railways, the development of the South Philadelphia Improvement project, covering the comprehensive replanning of 5000 acres in the southern section of the city for commercial, industrial and residential purposes; the widening of Delaware Avenue; the construction of concrete bulkheads and three large municipal piers along the Delaware River front; the dredging of the Delaware River from the city to Marcus Hook before the department of which he now becomes director was created and the laying out and opening of many important streets, parkways and parks. In 1905 and 1906, in addition to his other duties, he was acting chief of the Bureau of Filtration and directed the work then in progress for the improvement and filtration of the water supply of the city.

George E. Datesman

Mr. Datesman was graduated in civil engineering from Lafayette College and began professional work in architectural lines in Des Moines, Iowa. He spent one year subsequently in mining work and then entered the service of the City of Philadelphia as draftsman. For three years, until 1888, he continued with the city and then for three years more was in private practice in Germantown. He returned to the Bureau of Surveys as chief draftsman in 1891 and has been with the office ever since.

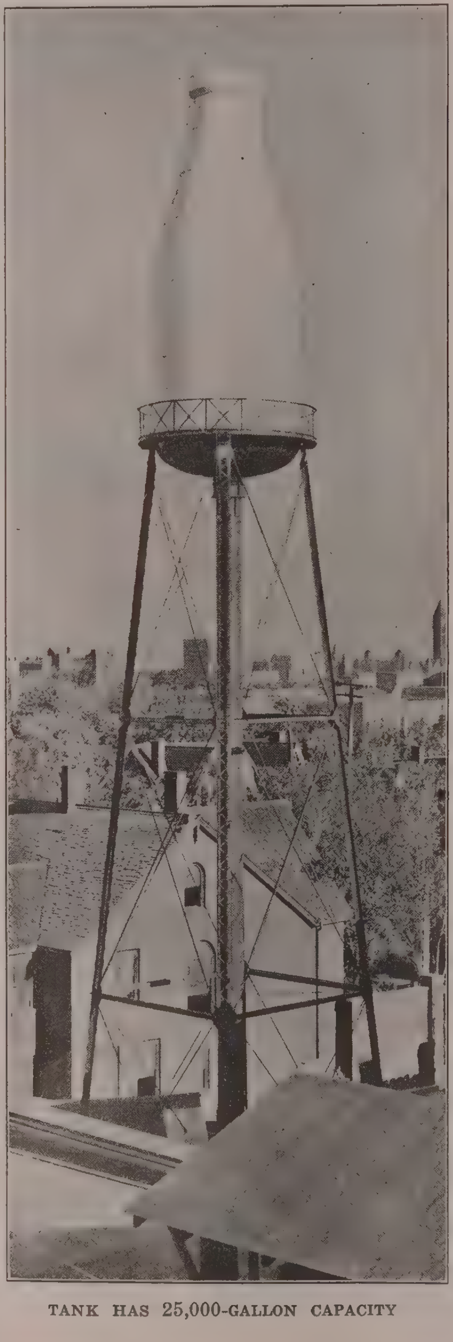
He has been associated with his chief, Mr. Webster, in the important work carried on in the department since his connection therewith. He has given special attention, however, to sewer design and sewage disposal, making a trip to Europe in the interests of the city. On that trip, too, he studied general municipal problems, such as boulevard and parkway development, urban transportation systems, especially subways; foreign street extension and pavement methods, and the financing of municipal improvements. With his wide experience he comes to the headship of the Department of Public Works with excellent preparation. He will, after the first of January, have direct charge not only of the works with which he has been associated, for the Bureau of Surveys is a sub-department of the Department of Public Works, but will also have supervision over other engineering activities of the city, including the work of the highways bureau.

Million Acre-Feet Added to Reclamation Service Storage Capacity

More than 1,000,000 acre-feet were added to the capacity of its storage reservoirs by the U. S. Reclamation Service during the past year. Four large and interesting dams were brought practically to completion, namely: The Arrowrock, the highest in the world; the Elephant Butte, which impounds the largest quantity of water of any artificial reservoir in the world except Gatun Lake; the Grand River, which is the longest roller-crest dam in the United States, and the Lahontan. Water was furnished to irrigate more than 750,000 acres of land and to grow crops worth $16,500,000. The total expenditure during the year for building dams and other irrigation works was $15,000,000. Construction completed included 753 miles of canals, 284 miles of waste-water ditches and open drains, 60 miles of irrigation and drainage pipe lines, 747 bridges, 1079 culverts, 311 flumes, 51 miles of roads and 178 miles of telephone lines. Irrigation canals were lined with concrete to a total length of 54 miles. The excavation of earth and rock amounted to 17,000,000 cu. yd. and 750,000 cu. yd. of concrete were placed.

Combine Novelty with Utility in Design of Steel Water Tank

A novelty in the way of steel tank design resulted from the decision of the City Dairy Company of Toronto, Canada, to combine advertising with utility in a steel water tank to be erected at its plant for fire protection purposes. The tank has a capacity of 25,000 gal. and is modeled after one of the company's standard quart bottles. It is 13 ft. in diameter and 35 2/3 ft. high, with its bottom at an elevation of 70 ft. above the ground, and is painted a pure white. The steel plate construction of the big bottle is similar to that of the standard water tanks of the manufacturer, the Canadian-Chicago Bridge & Iron Works of Bridgeburg, Ontario and Chicago, by whom it was designed and erected. The 4-post tower on which it is mounted is also of standard construction, designed to meet the requirements of the Canadian Board of Fire Underwriters.



TANK HAS 25,000-GALLON CAPACITY

St. Paul Electric Locomotives Perform Well in Test Run

The first actual tests on the Chicago, Milwaukee & St. Paul Railway's newly electrified mountain divisions in Montana were made Dec. 8 by officials and directors of the system, accompanied by officials of the General Electric Company. The completed sections of the electrified district were toured in three special cars drawn by one of the new 260-ton 3000-volt electric locomotives. Passenger-train tests were made at speeds up to 70 miles per hour, after which the same locomotives were used in tonnage tests of passenger trains, pulling 2500 tons at a uniform speed of 16 miles per hour. At the conclusion of the tests the president and other officials who witnessed them expressed gratification at their complete success.

The regenerative braking device included in the equipment of the 3000-volt locomotives proved under the actual tests to be entirely successful. It was seen that the use of the air-brakes had been practically done away with except for station stops and emergency uses, and that an enormous saving could be expected in the lessening of wear and tear on track and equipment. The constant grinding of brake shoes on wheels is nearly eliminated.

Among those who accompanied the test "special" were A. J. Earling, president of the railway; C. A. Goodnow, assistant to the president, who has had charge of the electrification, and A. H. Armstrong, of the General Electric Company.

It is expected that the all-steel transcontinental trains of the railway will be operated electrically over the Continental Divide shortly after the first of the year.

Silver Rivet Supersedes Time Honored Cornerstone

Instead of the customary cornerstone setting, a silver rivet was driven into the steel work of a 26-story building being erected at Madison Avenue and Forty-second Street, New York City, by August Heckscher. When the building is completed the rivet will be exposed in a silver lined recess in the main entrance lobby.

Would Skirt Border of Country with Military Road

A bill has been introduced in Congress that provides for a national highway system, extending from coast to coast, to cost not more than $100,000,000, as a means of defence. The sale of long-term 3 per cent notes is proposed to raise the funds for the purpose.

The bill provides that the highway shall be constructed by army engineers and its construction and use shall be under such regulation as the President may prescribe. It would begin at Los Angeles, Cal., and proceed by a practical route to Jacksonville, Fla., then northward to New York and Portland, Me. At New York the westward route would start for Chicago and go from there via Minneapolis, the Dakotas, Montana and Idaho to Washington, then down the Pacific Slope to San Francisco, Los Angeles and San Diego.

First Span Placed on Columbia River Interstate Bridge

The first span of the Columbia River interstate bridge, connecting Portland, Ore., and Vancouver, Wash., was placed in position Dec. 6. The span is 265 ft. long and weighs 468 tons. It was loaded on four barges, which were towed by tugs up the river, and placed in position in approximately three hours.

Secretary of War Condemns General Dam Act—Advocates New Law

In his annual report the Secretary of War, Mr. Garrison, points out that the general dam act has prevented the development of water power on navigable streams and characterizes the law as a "makeshift which effectually prevents all development." Continuing he says:

"On the one hand it [the general dam act] does not offer the rightful and necessary inducement for an economical and profitable development, nor on the other hand would it adequately protect the interests of the public if development were possible under it. Even were it sufficient in these regards it has been demonstrated that it would be unworkable in another. It is a general dam act in name only; while purporting to lay down general conditions to cover development in all cases, it nevertheless requires in each case the further special authorization of Congress, an inconsistency which invites a disregard of the general conditions, makes of each application an independent legislative proposition, and subjects each project to the delay and hazard of congressional action."

In the next paragraph the Secretary points out that the usual use of electric power, in cities and in factories, is not the only outlet at the present time for hydroelectric energy. He points out that the fixation of atmospheric nitrogen, through the use of the electric furnace, offers a tremendous field for the use of cheap power—a matter of particular importance at the present time when nitrogen is so important a factor in military effectiveness. He therefore urges that Congress enact suitable legislation along the lines of that which failed to pass in the last Congress.

Hopes to Open East Half of Barge Canal in Another Year

Only one more season is needed to finish the Champlain Canal of the New York State Barge Canal system, and also a channel from the Hudson River to Lake Ontario via the Erie and Oswego branches, states Frank M. Williams, State engineer and surveyor, in the November Barge Canal *Bulletin.* On each of these units there is a single unfinished and unawarded contract. The approval by popular vote last election day of the bond issue for the completion of the whole improvement makes it possible to push the work on these two contracts, together with that on the few others not quite completed, provided the Legislature takes steps for the immediate issuing of the bonds. Mr. Williams points out that this should be one of the first acts of the Legislature.

The Erie Canal west of the Oswego junction contains several uncompleted parts. Legal complications are here largely responsible for the unfinished condition. There are numerous railroad crossings, causing delays both in coming to agreements with the railroads and in performing the work so as not to interrupt traffic. Because of the amount of work still to be done and the number of crossings still to be made, Mr. Williams thinks two seasons will be required to complete the western half of the canal.

Popularize Results of Geological Survey Scientific Investigations

Four guide books of the West, plainly written in the effort to make the geologic description of the country traversed readily understood by the average traveler, were published by the U. S. Geological Survey during the past year. This is the beginning of a definite movement to popularize the results of the scientific investigations of the Survey. Other results attained during the year, according to the annual report of the Secretary of the Interior, were the completion of geologic and topographic surveys in the United States, Alaska and Hawaii, aggregating nearly 112,000 square miles, the classification of about 23,000,000 acres of public lands and the publication of scientific, economic and statistical reports, aggregating 23,574 pages. In addition, special bulletins were prepared to meet the demand for authoritative information concerning possible sources of mineral products hitherto imported, and an extensive correspondence was conducted to bring producers and consumers together. This service was rendered, the report points out, with the purpose of making America more independent industrially.

Work Started on $5,000,000 Additions to Inland Steel Company Plant

Work has been started on additions to the Inland Steel Company plant, Chicago, which will cost $5,000,000. Eighteen open-hearth furnaces will be constructed, increasing the output by 1,000,000 tons. The work is being done by company forces and, it is expected, will be completed by next fall. The excavation has been started and concrete work will continue throughout the winter.

Want Commission to Study Methods and Results of Land Settlement

Believing that conditions have arisen in certain sections of the country which are retarding rural development and making it difficult for farmers of small capital to become owners of the land they cultivate, the National Conference on Marketing and Rural Credits, held Nov. 30-Dec. 2, adopted the following resolutions:

"We believe that the remedy for these conditions existing in the irrigation sections is to be found in legislation by the states, or by the nation and the states, which will provide money to be loaned settlers to aid in the preparation of public land for cultivation and to the purchase of such privately owned land to be resold to settlers under methods and conditions similar to those now in successful operation in Australia, New Zealand and other countries.

"As such legislation would involve a radical departure from past methods and policies and as the systems of other countries would have to be modified to conform to our needs and conditions, the first step toward the inauguration of such legislation should be a comprehensive investigation of the subject.

"The conference, therefore, favors and recommends to Congress the appointment of a commission of five members to investigate the methods and results of land settlement in the West and other parts of this country where settlement of cut-over lands, drainage of swamp land and irrigation must be undertaken, as well as the causes and results of tenant farming in the entire country, and to prepare a report with recommendations as to the measures needed to remove the obstacles to acquiring farmers and the modifications needed in the successful land settlement system of other countries to insure their effective operation here."

California Railroad Commission Reports on Activities

In a letter of transmittal accompanying the annual report of the California Railroad Commission which appears in print this month, the following figures are given: During the fiscal year ending June 30, 1915, 675 formal applications and 241 formal cases were decided. Valuations made by the commission included the following: Railroad, $97,509,514.10; water, $37,100,086.00; electric, $30,851,929.93; telephone, $8,493,177.72; gas, $6,961,543.22; wharf and warehouse, $434,394.76; total, $181,350,645.73. In 99 per cent of the formal proceedings decided by the commission its orders have become effective without litigation, while the commission has won all of the last eleven successive cases decided by the court.

High-Grade Men for Factory Executives in Demand

According to the report of Arthur Keisel, secretary of the American Association of Engineers, 29 S. La Salle Street, Chicago, there is a call for high grade men as factory executives, and the supply of men in the civil engineering field is about equal to the demand. The association has attained a membership of 260, and, through its service clearing house, one hundred engineers have been put in touch with positions in the last two months, although not all of them have been placed. Of these only forty were members. No one belonging to the association is out of employment, so it is necessary to go outside to fill many of the openings.

National Employment Exchange Placed 3894 During Year

During the fiscal year ending Sept. 30, the National Employment Exchange, 30 Church Street, New York City, placed 3894 workers in positions. The general mercantile branch placed 2354 of these and the manual labor branch 1540. The first listed 3289 orders and the second 2202. In the latter part of the year extensive orders were received for gangs of laborers, mechanics and similar classifications, which the exchange was unable to fill due to a scarcity of applicants. The placements included only 70 laborers. Operations for the year showed a net loss of $2,084, as compared to a loss of $4,898 for the previous year.

News of Engineering Societies

The Pennsylvania State College will give a short course in the latest developments of highway engineering Dec. 27-31.

The National Society for the Promotion of Industrial Education will hold its annual convention at Minneapolis Jan. 20-22, 1916.

The Louisiana Engineering Society heard Burrus D. Wood speak on "Modern Diving and Wrecking Methods on the Mississippi" at a meeting held in New Orleans Dec. 13.

The Southern California Association of Members of the American Society of Civil Engineers held a dinner at the Hotel Clark, Los Angeles, on Dec. 8, at which Capt. Charles T. Leeds presided. Following the dinner the Big Creek power project of the Pacific Light & Power Corporation was discussed by R. C. Starr, hydraulic engineer. About fifty members and guests attended.

The Indiana Engineering Society and the Indiana Sanitary and Water Supply Association will hold their annual meetings simultaneously, Feb. 2-5, 1916, at the Claypool Hotel, Indianapolis. Major-General W. C. Gorgas, U. S. A., will be the principal speaker at the meeting of the latter organization. The programs of both meetings will be so arranged that delegates to each may attend the other, and the subjects discussed will be such as to be of interest to both.

The Iowa Section of the American Waterworks Association held its first annual meeting at the State University of Iowa, Iowa City, Dec. 3-4. Dr. Edward Bartow of the State Water Survey of Illinois spoke on the activated sludge process of sewage purification. The following officers were elected: Chairman, Robert N. Kinnaird, chief engineer of the Des Moines Water Company; vice-president, C. H. Streeter, superintendent of the Cedar Falls water and electric plant; secretary, J. J. Hinman, Jr., senior water bacteriologist and chemist, State Board of Health Laboratory; directors, William Molis, superintendent of the Muscatine City Waterworks, and J. P. Berry, superintendent of the Waterloo Waterworks.

The New York Section of the American Waterworks Association held its December meeting at the Manhattan Hotel, New York City, Dec. 15. A paper by G. E. Willcomb on "Resanding Problems at Albany" was read and F. E. Hale and Edgar M. Hoopes, Jr., city engineer of Wilmington, presented papers on "Iron Removal by Rapid Sand Filtration" and "Airbound Difficulties." Mr. Hale's paper was based on experiences of the New York City Department of Water Supply, Gas & Electricity in dealing with Long Island well water. Mr. Hoope's paper was based on experiences at the Wilmington plant. Short papers were also delivered by F. W. Green, G. R. Spalding, E. G. Manahan, S. M. Van Loan and A. A. Tolson.

The University of Illinois will give a short course in highway engineering Jan. 10-21, 1916. Arrangements have been made for one or more addresses by the state highway engineers of Wisconsin, Iowa and Kansas. Other prominent highway engineers will participate. Papers will be presented by members of the staff of the department of civil engineering and by other members of the University faculty. Several county superintendents of highways have agreed to deliver addresses upon subjects for which they are peculiarly fitted and others have consented to lead in the discussion of the formal papers. The addresses, discussions and demonstrations will be such as to be of interest to highway engineers, to township highway commissioners and to contractors engaged in bridge and road construction.

Personal Notes

L. P. SCOTT, assistant engineer with the Illinois State Highway Department, who has been on leave of absence for the past year acting as county superintendent of highways for Carroll County, Illinois, will return to the State Highway Department Jan. 1 in the capacity of chief draftsman in the road department.

S. C. CAMPBELL has resigned his position with the Illinois State Highway Department to accept appointment as county superintendent of highways of Carrol County, Ill., to be effective Jan. 1.

ROBERT B. MARSHALL, chief geographer of the U. S. Geological Survey, has been appointed general superintendent of national parks, succeeding Mark Daniels, whose resignation is noted elsewhere in these columns. Mr. Marshall entered the service of the Geological Survey in 1889 as field assistant. In 1893, as topographer he began a survey of Yosemite Park and, in 1904, he served as a member of the commission constituted to consider changing the boundaries of that park. He was appointed chief geographer of the Geological Survey in 1908, and, in that capacity, made exhaustive studies of all the national parks.

B. H. BURRELL, senior highway engineer, U. S. Office of Public Roads and Rural Engineering, has been directed to make an investigation of the proposed highway from San Diego, Cal., to Washington by way of El Paso, Tex. Mr. Burrell studied engineering at the California Military Academy and was with the California Bridge Company from 1890 to 1897. For the next four years he was engaged in private practice, with the exception of about six months spent in the office of the city engineer of Oakland, Cal. In 1901 he went to the Philippine Islands as chief draftsman with the city engineer of Manila. He became superintendent of sanitation in that city the following year, and provincial supervisor of La Union Province in 1903. From 1906 to 1907 he was district engineer in charge of Engineering District 12 and, from the latter year until 1909, engineer in charge of contract for the Philippine Government in Manila Harbor. He returned to the United States in 1910 and, after a few months spent in architectural work in Oakland, Cal., was appointed civil engineer and superintendent of construction for the U. S. Quartermaster's Department. He entered the service of the U. S. Office of Public Roads in 1911.

CARL H. REEVES, formerly assistant engineer with the Public Service Commission of Washington, and, previous to that, civil engineer with the Stone & Webster Engineering Corporation, has opened offices in the Henry Building, Seattle, Wash., to engage in practice as consulting engineer, specializing in municipal and highway work. He was graduated from the University of Washington in 1901. His first service, after graduation, was as transitman for the Spring Valley Water Company at Port Townsend, Wash. From this work he went to the office of the city engineer of Seattle, where he remained until 1906, when he became assistant engineer of outside work for the Seattle Electric Company. In 1911 he was appointed bridge and field engineer for the Stone & Webster corporation, with which company he continued until March of the present year, attaining the grade of civil engineer in 1914. While with the Public Service Commission of Washington he had charge of street and interurban railway track, roadway and bridge appraisals.

J. NORMAN JENSEN, architectural engineer in the Chicago building department, has been restored to office by court order, following his suspension in April on charges of the building commissioner. The charges were not proved and on May 27 his name was put back on the eligible list, another man being named for his position. The courts have now ruled that Mr. Jensen must be put back on the pay roll.

J. KAPPEYNE, formerly connected with the valuation of the utilities in the District of Columbia, has been appointed engineer to the Public Utilities Commission of the District of Columbia. He was born in Holland in 1882 and received his professional education at the Polytechnical School of Zurich in Switzerland. His first practical experience was obtained in the United States on the design and installation of the equipment of the subaqueous tunnels of the Hudson & Manhattan Railway Company and of the New York City subways now in the course of construction. Previous to going to Washington he was engaged on the valuation of the street railways of Greater New York for the Public Service Commission, First District.

EDWIN JENNINGS, formerly connected with the Department of Bridges, New York City, has resumed practice as consulting engineer at 835 Broadway, New York City.

J. FRANKLIN DIGGS, JR., formerly resident engineer of the southern division of the bureau of sanitary engineering of the Maryland Department of Health, has been transferred to the western division, with offices at Hagerstown, in a similar capacity.

MARK DANIELS has resigned from the position of general superintendent of national parks. He occupied the office for somewhat over a year, during which time, among other works, he designed a complete road and trail system for five of the national parks.

J. B. LIPPINCOTT, consulting hydraulic engineer, of Los Angeles, has been retained by the city of Santa Monica, Cal., to report on the plans for the storm water drainage system proposed for that city.

CHARLES F. PLACE, formerly city engineer of Hayward, Wis., has been appointed prospect engineer on a 10,000-acre irrigation project at Clearmont, Wyo. The work will result in the adapting of a large cattle ranch to sugar beet growing.

CLINTON R. GOODRICH, formerly construction superintendent with James Stewart & Company, Inc., is now associated with the Dale Engineering Company, general contractors, of Utica, N. Y. He was graduated from Cornell University in 1905 and for the past six years has been in charge of building work for the Stewart company, principally in the Southwest, but for the past year on the development of the Ilion plant of the Remington Arms & Ammunition Company.

E. F. CYKLER, formerly assistant engineer to H. J. Brunnier at Berkeley, Cal., has been appointed chief engineer for the Lord-Young Engineering Company, Ltd., on pier construction and dredging contracts at Honolulu, T. H.

OSCAR S. STRAUS, formerly secretary of the Department of Commerce and Labor and Ambassador to Turkey, has been named chairman of the Public Service Commission of the First District, New York, succeeding Edward E. McCall, removed.

H. GILBERT KARGES has been appointed superintendent on the construction of a $500,000 hotel at Evanston, Ind. He was graduated from the University of Illinois in 1914.

DR. D. S. JACOBUS, advisory engineer for the Babcock & Wilcox Company, manufacturer of steam boilers, superheaters and mechanical stokers, of New York City, and special lecturer in experimental engineering at Stevens Institute of Technology, was elected president of the American Society of Mechanical Engineers at the annual meeting of that society, held in New York City, Dec. 7.

M. M. O'SHAUGHNESSY, city engineer of San Francisco, expects to attend the hearing before Secretary of the Interior Lane, at Washington, D. C., Jan. 26, 1916, on the John Hays Hammond claims for water and power rights in the Poopenaut Valley, which are said to conflict with the Hetch Hetchy grant to San Francisco. The hearing was originally set for Dec. 13, but was later postponed.

THOMAS W. RANSOM, consulting mechanical engineer in the office of the city engineer of San Francisco for a number of years, has tendered his resignation to take effect Jan. 1. Mr. Ransom retires to take up private practice, and has opened engineering offices in the Mills Building, San Francisco.

Obituary Notes

FRANK BAILIE, of the H. K. Porter Company, manufacturer of steam and compressed air locomotives, of Pittsburgh, died Dec. 14.

W. W. RAMSEY, president of the Ramsey Engineering Company, of Chicago, died Dec. 3 at the age of 69. He was one of the early pioneers in the field of reinforced concrete and in the development of expanded metal. The business of the firm will be continued by W. E. Ramsey, his son.

EMORY A. ELLSWORTH, for four terms city engineer of Holyoke, Mass., and a well-known architect and engineer of that city, died at his residence on Dec. 8. He was senior member of the firm of Ellsworth & Howes. Mr. Ellsworth had been in practice in Holyoke for forty years and was sixty-two years of age. He was the designer of many public and private buildings, including some of the plant of the Massachusetts Agricultural College at Amherst.

SALEM D. CHARLES, chairman of the Boston Board of Street Commissioners, died at the Worcester City Hospital on Dec. 9. Mr. Charles had been in poor health for over a year. He was elected to the board in 1899 and later succeeded the late John P. Dore as chairman.

LIEUT.-COL. CHARLES S. BROMWELL, Corps of Engineers, U. S. A., died at Honolulu, Hawaii, Dec. 10. He was graduated from West Point in 1890. At the time of his death he was in charge of defense work in Honolulu and Pearl harbors and of the improvement of Hilo, Honolulu and Kohului harbors. Previous to that he was in charge of the Cleveland engineering district. For several years he served as military aide to President Roosevelt.

B. F. Affleck Heads Cement Manufacturers' Association

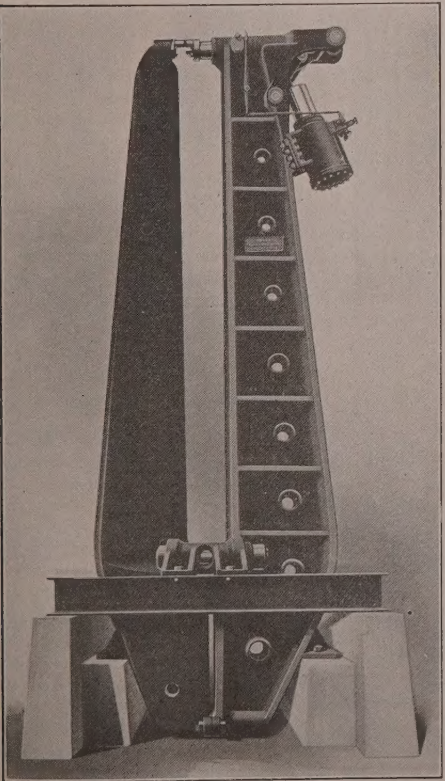
At the annual meeting of the Association of American Portland Cement Manufacturers, in New York, Dec. 13 to 16, B. F. Affleck, of Chicago, president of the Universal Portland Cement Company, was elected president of the association, succeeding John B. Lober, of Philadelphia, president of the Vulcanite Portland Cement Company. Mr. Lober retired after a service, not continuous, however, of nine years as president of the association and received an ovation upon the presentation to him at the annual dinner of an exquisite silver punch service. Not content with this evidence of their esteem and affection, his colleagues presented him with a phonograph and a record cabinet of regal proportions, that his leisure might be filled, as Mr. Sinclair said in the presentation speech, with the best that opera, or perchance vaudeville, might afford.

Enlarged plans for the association's activities were considered and adopted.

Largest Pneumatic Riveter Has Pressure of 100 Tons

The big riveter shown herewith has a wide opening with toggle-joint motion and gradually increasing pressure until the rivet is gripped, after which a simple lever motion under maximum pressure for a considerable space drives the rivet up tight. This combination, once adjusted for a given length and grip of rivet, needs no further manipulation to drive "steam-tight" rivets for heavy pressure, regardless of ordinary variations in the length of rivets, size of holes or thickness of plates. Such variations have prevented ordinary pneumatic riveters from being used on work of this sort, although a hydro-pneumatic type of riveter has been developed and is preferred by a few for this work to the hydraulic machines usually employed.

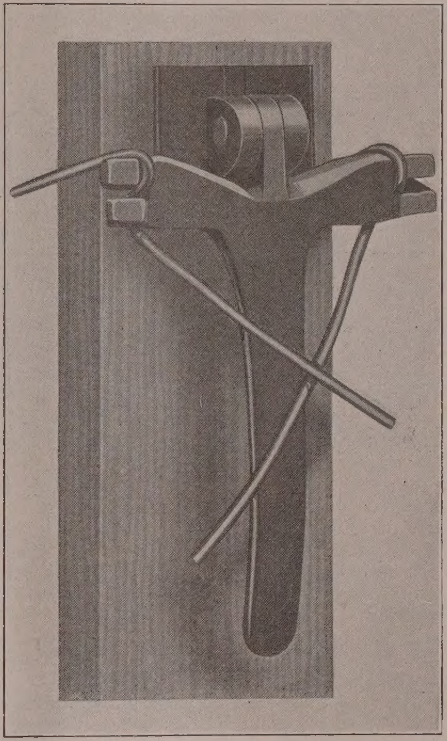
Two of these riveters, with a reach of 21 ft. and capable of exerting a pressure of 100 tons on the rivet die with 100 lb. air pressure, have just been built by the Hanna Engineering Works of Chicago, for which the Vulcan Engineering Sales Company is agent. They are said to be the largest pneumatic riveters ever constructed. This type is said to avoid the drawbacks of the hydraulic and hydro-pneumatic types of riveters, and to have besides many advantages of its own.



RIVETER HAS TWO MOTIONS

You Can Put This Form Clamp On in Ten Seconds

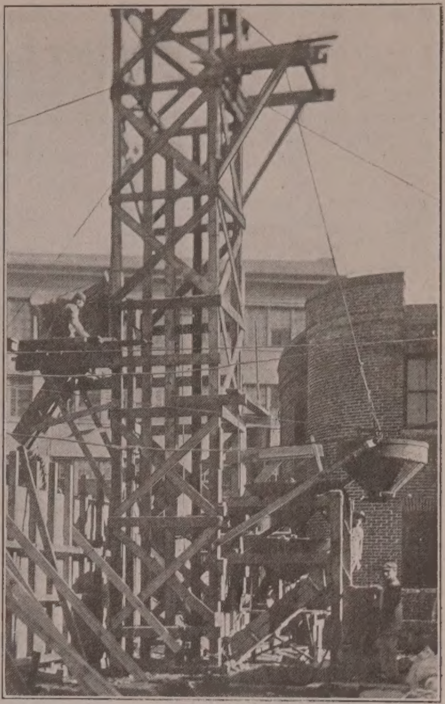
A wire form clamp, which can be placed on the wire, pushed against the form and locked in ten seconds, has been placed on the market for the first time. It can also be removed as quickly as applied without cutting the wires. A toggle lock, which insures a positive automatic locking action, is used. Wooden wedges, twisting the wires and boring holes in the forms are all eliminated. The new clamp, as shown in the accompanying photograph, is a one-piece device, weighs 24 oz. and will handle up to 3/16-in. wire. Only one clamp is necessary for a complete tie. The Universal Form Clamp Company, Chicago, are the manufacturers.



FORM CLAMP OF EFFICIENT OPERATION

Lever Elevator Attached to Tower Feeds Mixer

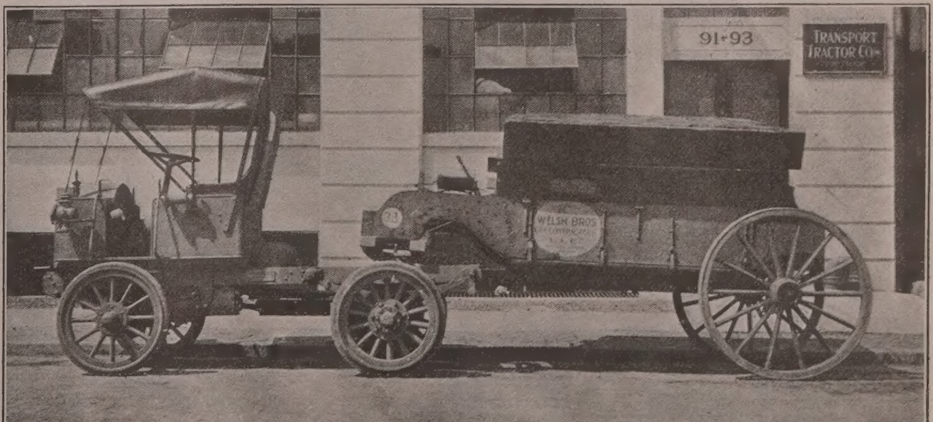
An elevator consisting of a charging hopper pivoted at the outer ends of two levers hinged to the hoisting tower has been designed by the Automatic Concrete Mixer Company, Inc., at Providence, R. I., and used with success in tower installations where Haines mixers are employed. It enables the mixer to be set above ground without requiring any inclined runways for charging it. The hopper is hoisted by the regular tower engine, and dumped by opening its lower gate. When being charged, the top of the hopper is level with the ground. Its rim is supported by wood blocks at a sufficient height to prevent the gate handle from striking the bottom of the pit dug to receive it.



LEVER ELEVATOR IN USE

Five-Ton Tractor Can Be Used Economically for Two-Ton Loads

A 5-ton gasoline tractor has been placed on the market which can be used economically, its manufacturer claims, for loads as small as 2 tons. It is built to haul loads either by means of a patented device furnished with the tractor or on specially built trailers. The advantages claimed for it are small initial investment and economy in fuel, tires and repairs. A 25-hp. engine is used, working through a massive worm driven axle with an especially large gear reduction. All working parts are protected from mud and water. The tractor is illustrated in the accompanying cut. It is manufactured by the Transport Tractor Company of Long Island City, N. Y.



TRACTOR BUILT TO HAUL LOADS EITHER BY MEANS OF A PATENTED DEVICE OR ON SPECIALLY BUILT TRAILERS

High Freight Rates Bar Cement from South America

With a tariff preference of 20 per cent in their favor, American cement manufacturers are not doing well in the Brazilian markets in competition with European exporters, according to an official statement of the Department of Commerce. European firms have been given an advantage in freight rates that more than offsets the preferential tariff. The freight rate from England to Pernambuco, for example, is $9 per ton, while the rate from New York is $12.

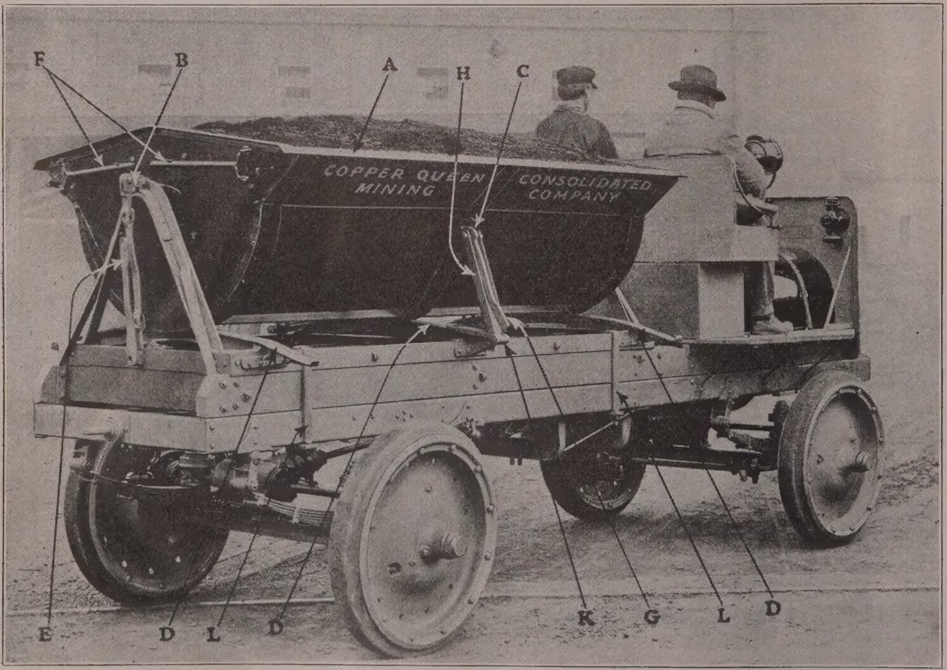
According to statistics furnished by the Bureau of Foreign and Domestic Commerce, the imports of cement into Brazil have grown to important proportions in recent years. In 1913, the latest year for which statistics are available, the total imports for the country were valued at more than $7,000,000. This was an increase of approximately $2,000,000 in a year's time. Of the 1913 imports, $3,000,000 worth came from Germany, $2,000,000 worth from England, $900,000 worth from Belgium and $750,000 from the United States, other countries furnishing smaller amounts.

Two-Way Side Dump Motor Truck Makes Unloading Possible

By means of the new Lee two-way side dump body the whole operation of unloading a motor truck for bulk materials has been made possible, it is claimed, for the average driver in ½ minute. An expert can do it in from 20 to 25 seconds.

The act of dumping is performed as follows: A handle (G) in the middle of the body is raised, thus releasing an eccentric stop (C). The support (H) is then free to move outward, so the operator now pulls the handle (G) toward him and allows the support (H) to hang downward from the hinge (K). He then grasps another handle (E) and pulls it sideways, one way or the other, thus releasing the catch (B) and a similar catch in front, to which it is connected by a longitudinal rod. The body is then ready to be dumped, which is done by pulling out one of the handles (F) and pressing on it easily until the body rolls on its rails (D), the distance through which it rolls being governed by the length of restraining chains under the body. The operator dumps and rolls back the body with the same motion. The support (H) and the catch (B) are then replaced, both front and rear catches being operated at the same time by either the handle at the rear or the similar one at the front of the body.

The body was designed and is made especially for Jeffery Quad truck, manufactured by the Thomas B. Jeffery Company, Kenosha, Wis.



TRUCK CAN BE UNLOADED IN ONE-HALF MINUTE BY AVERAGE OPERATOR

Only One Man Needed to Operate This Back Filler

With its scraper swung from a 25-ft. boom the latest back filler to be placed on the market requires only one man for its operation. The boom is 15 ft. long in its regular size, but by the adjustment of a 10-ft. extra section the 25-ft. length is obtained. The machine is equipped with a 10-hp. Novo engine. The operating levers are located at the rear of the machine and are so grouped that they can be reached by the operator from his seat. A self-acting scraper, 4 ft. wide, built up of steel angles and oak planks, is provided for handling the dirt. The back filler, which it is claimed has made four swings per minute, is manufactured by the Pawling & Harnischfeger Company, Milwaukee.

NEW TYPE OF BACK FILLER IN ACTION

Business Notes.

E. F. Houghton & Company of Philadelphia have purchased outright the American Regulator Company, manufacturer of the American regulator system of temperature control for large buildings, and will enlarge their plant to accommodate the new acquisition. Mr. Bonnet, formerly president of the Regulator Company, will manage the department.

The Syndicate Club, composed of executives of the Garford Motor Truck Company of Lima, Ohio, and officials of parts and material companies, recently held its annual convention at Orchard Island, near Lima. The club was formed to bring together the Garford Company and those affiliated with it in a business way, and it is believed to be the first organization making for a greater spirit of co-operation between the motor truck builder and material manufacturers ever established in the industry.

The Chicago Bridge and Iron Works has moved its general sales office from Washington Heights to the Old Colony Building, 37 W. Van Buren Street, Chicago.

Blaine S. Smith, general sales manager of the Universal Portland Cement Company of Chicago, was elected general secretary of the Chicago Association of Commerce at its annual meeting, held Dec. 8. He has served the association actively for several years as chairman of the Illinois committee and, until now, as chairman of the Ways and Means Committee Council. He was appointed general sales manager of the cement company early this year.

The H. M. Byllesby Company, engineers and constructors, Chicago, have organized the Byllesby Mercantile Corporation, to engage in a general exporting and importing business between this country and Central and South America.

Trade Publications

Southwark Foundry & Machine Company, Philadelphia. Catalog, 8¼ x 11 in., 40 pages, illustrated. The description covers every feature of the Southwark-Rateau centrifugal pump. Appended are instructions for installing, starting, stopping and maintaining centrifugal pumps.

Keuffel & Esser Company, New York City. Pocket handbook, 3 x 5¾ in., 39 pages. Gives solar ephemeris for each day of the year 1916, together with tables of latitude coefficients, mean refraction corrections and other data useful in field astronomy and surveying. Interspersed with the tables are testimonials relative to the company's make of instruments.